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NOVEMBER, 1853.

CIVIL ENGINEERING.

On Railway Axle Lubrication. By Mr. W. Bridges Adams, of London.*

In the economy of railway transit an idea has prevailed that increase of speed increases cost in a compound proportion, in many other things than the mere excess of fuel consumed in the locomotive. This is correct only in reference to imperfect appliances. If, for example, the rails deflect beneath the rolling loads, the substructure will be displaced, and increased speed will greatly increase the displacement. If the wheel peripheries be out of order, the greater the speed the greater will be the destruction; and so also, if the rail surfaces or joints be out of order. And in proportion as the springs are inefficient, *i. e.*, are non-elastic, or do not act through sufficient space to moderate the shocks, so will the destructive wear be increased by increased speed. But were all parts of the system—ballast, sleepers, rails, wheels, axles, journals, bearings, lubrication, and springs—rendered as perfect as is within the scope of mechanical art, there seems to be no reason why increased speed should involve any extra cost beyond the increased consumption of fuel, oil, and grease, provided all parts of the system be proportioned to each other.

In increasing speed with imperfect mechanical arrangements, one of the most prominent difficulties occurs in preventing axles and axle boxes from heating; the cause of the heating is in the imperfect lubrication. The word lubrication literally signifies slipperiness, but this does not express the precise action. Oil, or grease, or soap, interposed between two metallic bodies moving one upon the other, is composed of a series of small globules, which keep the bodies separated, and serve as rollers.

* From the London Artizan, July, 1853.

The surfaces of metallic bodies, however apparently smooth, are composed of salient and re-entrant angles of larger or smaller size, according as the metal is hard and polished, or soft and rough. Therefore the more imperfect the structure of an axle and bearing, the more viscid must be the lubricating material to keep them from contact. If the cushion of lubricating material be insufficient in extent, contact ensues between the salient angles of the metal, and heating takes place to such an extent as to boil away the lubricating material and drive it off.

In calculating the surface bearing of axles, there are two circumstances to consider:—First, actual weight to be borne; and, secondly, the amount of concussion adding to the effect of the weight, which latter will much depend on the efficiency of the springs to moderate the effect of the shock.

Before the advent of railways, mail coaches and private carriages, with a maximum weight of three tons, were constructed with axles case-hardened, and with a bearing surface on each arm equivalent to thirty square inches. This is equivalent to about 56 pounds per square inch on the bearing.

Mr. Nicholas Wood, in his experiments on axle friction, found that, with the best oil and with favorable circumstances, a superincumbent weight of 90 lbs. per square inch gave the minimum of friction.

Some of the earliest railway axle bearings were 4 inches in length by $2\frac{1}{4}$ in diameter, something under 14 inches of total bearing surface, fitted according to Mr. Wood's calculations, only for a wagon of two tons total weight. It would seem as though these sizes had been calculated from the fixed shafting of factories, without any calculation of concussion. Probably this was the reason why viscid soap was substituted for fluid oil, increasing the toughness of the material used for lubrication to make up for the want of bearing surface. In railway practice it is found that the soap or grease which serves well in the winter is too fluid in the summer, a sure proof that the bearing surface is far too small for any lubrication with oil, which offers the minimum amount of friction. A strong objection to soap lubrication is, that it requires considerable amount of friction in the winter time to make it fluid; and it is sometimes difficult to start a train into motion when the grease has been frozen.

In the wheels of highway carriages the oil chambers are contained within the wheels, and revolve with them, which process involves the efficient lubrication of the axle. In the axle boxes of railway carriages the grease or oil does not revolve. In the highway wheels, the oil always has a tendency to rest in the well or magazine below the level of the axle. In the ordinary axle boxes of railway carriages the grease or oil is above the level of the axle, and, as the axle revolves, the oil or grease, or rather the grease (oil not being used, except in engines), passes through a hole or holes in the bearing brass, which lies on the upper half of the axle; and thus the process is like that of a handmill, the lubricating material is supplied on the upper surface of the axle, and passes away at the lower like grist. To make the lubrication more certain, the holes are of large size; and this involves an evil by diminishing the bearing surface at the most important point. If these holes get stopped, the lubrication ceases and heating ensues; and there are no means to remedy the evil, save by lifting the bearing from the axle and inserting more grease.

Thus, in the ordinary railway grease box, there is not only a great waste of grease, but also a very imperfect mode of securing lubrication. The well made, case hardened axles of a common road carriage are capable of running 5000 miles over a bad road with once oiling with a small quantity of oil, while railway axles require greasing every 100 miles or less, with some few exceptions.

Impressed with these imperfections, the writer some years back began to consider the best means of remedying them. It was evident that the only mode of applying grease or oil to a large surface of the axle bearing was at the under side. In the common mode of an open bottom this was scarcely practicable; and the question was, could the bottom be effectually closed without so confining the axle as to make partial heating dangerous. This was accomplished by applying a flexible connexion between the axle and the inner side of the axle box, and making the bottom of the box tight. In this mode, the grease filling the lower part of the box, the whole under surface of the axle was bathed in it, while all dirt and grit were excluded. Moreover, the grease being as it were in a well below the axle, any accidental extraneous matters could sink to the bottom, and not be brought in contact with the wearing surface. And, supposing the upper holes to be entirely stopped, lubrication would go on notwithstanding. It must be evident that feeding from above in all cases involves the chance of dirt getting to the axle, which feeding from below obviates.

To provide against accidental injury to the axle bearings, the writer provided also for a mode of shrinking on a false bearing upon the axle arm; so that, in case of cutting, it might be removed and replaced. The following is a description of the axle box invented and patented by the writer, in May, 1847, which is shown in the accompanying drawings:—

Fig. 1.

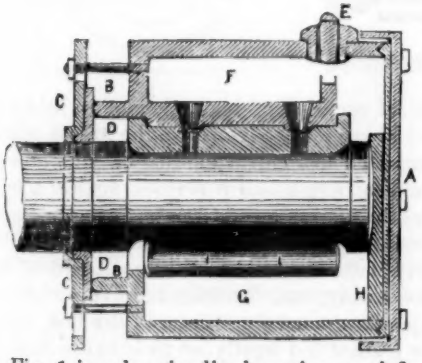


Fig. 2.

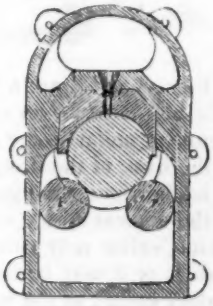


Fig. 1 is a longitudinal section, and fig. 2 a transverse section, of the axle boxes employed on the North Kent line. The top of the box is circular, for a peculiar arrangement of springs; the box is cast open-fronted, with a movable front, A, to attach by screws, a grease-tight joint being maintained by an elastic substance between. In this mode the interior of the box can be inspected, and a new brass applied, without lifting the carriage. The back of the box round the axle is cast with a

round edged projecting lip, B B. A plate of metal, C C, with a centre hole fitting the axle, is secured by bolts to the back of the box, with a piece of leather, D D, the orifice of which is enlarged into a partial pipe form round the axle, to give increased bearing surface. This leather presses equally on the axle and on the lip of the box, and thus a tight joint is maintained, which preserves the grease without overflowing above the level of the bottom of the axle. The bolt holes in the metal plate are oblong vertically, so that when the upper bearing brass wears and causes a corresponding wear in the plate and leather, and a consequent leak below, the two latter may be drawn upward to fit the lower part of the axle. At the top of the box there is a screw tap, E, for feeding, with holes through it, to admit the ingress and egress of air. This tap serves to feed an upper chamber, F, with holes to the axle as usual, and also to feed the lower chamber, G, which, in addition, catches the grease that falls through from the upper chamber by the working of the axle. A piece of hard wood, H, is applied between the end of the axle and the front of the box, to prevent wear of the shoulder-collar of the bearing brass. Two rollers of light wood, I I, float on the oil or grease in contact with the lower side of the axle, and thus carry up the lubricating material, if it happens to be below the level of the axle.

Fig. 3.

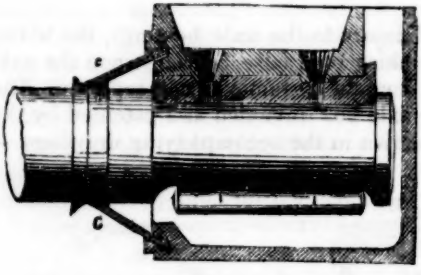
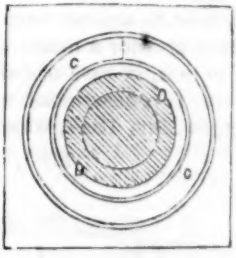


Fig. 4.



Figs. 3 and 4 are a longitudinal section and back view of an axle and axle box, also for an upper and lower feed. To retain the grease or oil, a conical metal spring, C C, is inserted in a corresponding circular groove at the back of the box; by its elastic expansion it presses against a strip of leather lining the groove, and thus forms a tight joint. The small end of the conical spring clips a leather pipe-collar, D D, fitted on the axle, which collar may either revolve with the axle in the small end of the spring, or it may be fixed to the spring, and the axle revolve within the leather collar; as the spring expands against the groove in the box, it has no tendency to press the axle or leather too tightly, so as to cause friction. The conical spring is prevented from turning by a stud; the edges of the spring overlap each other, to keep out dirt; and the hollow space between the spring and the axle may be filled with sponge or cotton waste.

Figs. 5 and 6 show a longitudinal section and back view of an axle box on a similar arrangement, in which a conical pipe of blocked leather, C C, is secured to the box lip by an elastic ring, D D, similar to a key ring, and clipped to the axle by a second ring, E E. Both the spring cone

and the leather cone will, by their free action, accommodate any irregular movement of the box, and prevent loose wear between both the metal plate and leather. In all cases where any material comes in contact with the revolving axle, it is essential that the surface be properly smoothed, that the pressure be as light as may be convenient, and the lubrication certain.

Fig. 5.

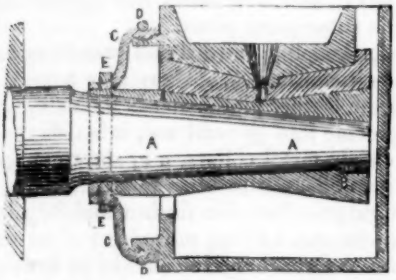


Fig. 6.

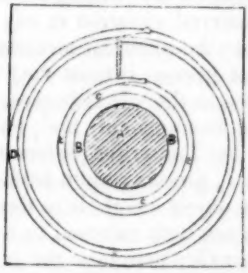


Fig 5, in addition to the axle box arrangement, shows a mode of applying movable journals to axle arms, either new or old. Thus, the journal, A A, may be forged down to a taper, with the object of extending the distance of the bearing from the wheel, or of increasing the diameter of the axle bearing. The movable bearing, B B, may be of wrought iron, or cast iron well got up and case-hardened; and manufacturers might be enabled to supply a superior class of axle box and bearing cheaply. Railway companies might thus be enabled, at comparatively little cost, to replace their axles, when rendered unsafe by long vibration in running. The hollow axle, shown at figs. 7 and 8, would be well adapted to this arrangement.

Fig. 7.

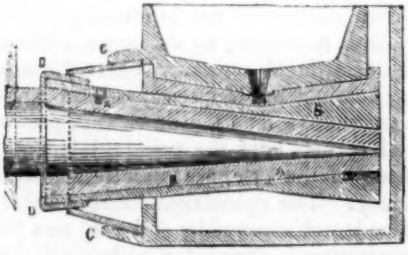
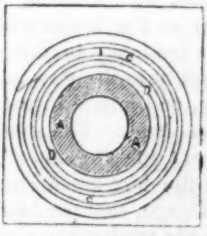


Fig. 8.



Great numbers of these boxes, with leather collars, have been applied, and have been found to answer the desired purpose.

It should be remarked, that it is desirable, in all cases, to get the axle bearings as long as is convenient, even when not required for bearing surface, for the following reasons:—The points of the springs which support the frames are at a considerable elevation above the axle bearing, and act with mischievous leverage to tilt the axle boxes laterally to the carriage, when the wheel flanches strike the rail. It is evident that, unless there be some proportion in the length of bearing to the height of

the spring, there will be a great strain upon the guards of the axle boxes to keep them steady.

The axle box described above is the first application of the principle of retaining the grease or oil, by closing in the back of the box.

Since the above described, similar contrivances have been brought out by various other parties, for the purpose of retaining the grease in the axle boxes; but it appears that the original application of the principle was that of the writer, in May, 1847; and there does not appear to be any material variation in any of the subsequent plans.

As to the practical mechanism for keeping out dirt and preserving the bath of grease, it must vary with circumstances. Many axle boxes are so close to the wheel bosses, that the leather pipe collar is the only practicable arrangement; and, having come into general use, it is difficult to vary, but the writer prefers the elastic metal collars, c c, shown in figs. 3 and 7, pressing upon leather pipe collars, d d.

The object sought is to form a tight joint between the box and the axle, which are both exposed to rough jolts and a tilting movement of the box on the axle; therefore the medium to form the joint should be flexible, and not liable to be put out of order.

The mode of lubrication from above the bearing has one objection, in the liability to accident by dirt getting on the arm, and from the holes wasting a most important part of the bearing surface; but the writer thinks it preferable to retain it, keeping the holes small, but merely as a security in case of any accident happening to the lower reservoir.

Two forms of journal are shown in the diagrams; one the double cone, figs. 5 and 7, the other the ordinary cylindrical journal with collars, figs. 1 and 3. There is an advantage in the double cone with the small diameter in the centre of the bearing, that it has a tendency to cause the lubricating fluid to press outwards from the centre while in rapid motion. The cylindrical bearing between collars has also this disadvantage, that the box is not kept in its position by gravity, but by a very small collar surface, which, being vertical, does not retain the lubricating fluid so easily as the horizontal surface; and, moreover, by its larger diameter, has a tendency to throw it off by centrifugal action. Where the boxes fit tightly to the guards, the collar bearings are frequently subject to rapid wear, and lateral thrust is more destructive than the downward pressure of the load. The small rounded corners next the collars, intended to prevent the "nicking" or breaking of the axle, are of little service to give the box a centripetal tendency. The cylindrical bearing has the advantage, that the bearing surface is not lessened by end play, and with the axle working in a bath of lubricating material, the collars will at all times be safe enough. In either case, of the cone or the cylinder, it is clear that the lubricating bath below will be the safest precaution against heating. As regards the strength of the axle, the cone journal has the advantage, by its gradual tapering form, supposing an equal amount of metal in both cases. The fitting of the wearing brass to the journal is a matter of greater nicety with the cone than with the cylinder; with cylindrical journals the usual practice is to make the bearing brass of considerably larger radius than the journal, so that it bears on a very small surface, which wears to a polish, and gradually extends to the half dia-

meter. In point of fact, railway bearings are made to grind themselves to a true fit to work, instead of being accurately ground and fitted beforehand, as in the case with nicer machinery.

The Chairman inquired what comparative results were obtained as to consumption of grease in the axle boxes tried on the North Kent line.

Mr. W. B. Adams said he understood that the axle boxes worked very satisfactorily, and with a reduced consumption of grease; but he was not able to give the results of the economy, as an exact comparison had not been made.

The Chairman observed that there appeared some difficulty in the conical spring proposed, for the purpose of making a close joint between the box and axle, and inquired whether it had been found to have sufficient elasticity to work well.

Mr. W. B. Adams said that the only plan which had been practically tried was the leather collar first described; he had not yet applied the conical spring, because there was not, in many cases, space enough to get it in between the axle box and the nave of the wheel, and therefore the leather collar only had been used, which had the advantage of taking up less space; but he thought the conical spring was preferable, and would make the most perfect joint, and there would be no difficulty in adopting it in modern carriages, as the projection of the axle from the wheel is now commonly extended to increase the width of the bearing.

The Chairman inquired how the grit was found to be kept out in Mr. Allan's sponge axle box, that was described at the last meeting.

Mr. Allan said that his axle box was designed for using oil, instead of grease; and the only way dust and grit was kept out was the proximity of the nave of the wheel to the face of the axle box, but it was found that the sponge prevented the grit from penetrating more than a short distance, about an inch or an inch and a half along the journal, as shown by the sponges, when taken out.

Mr. E. A. Cowper remarked, that it was an important desideratum to get a grease-tight joint at the back of the axle box, that would effectually keep out the grit, and not be interfered with by wear and motion of the box; and he thought that such a joint had yet to be accomplished. In the American axle box, described at a recent meeting, the leather flanch worked in a groove on the axle; it appeared a simple means for attaining this object, but some elastic provision for following up the wear was also wanted; this was proposed to be effected by the conical spring, though that plan might admit of further improvements, as there was generally very little room between the wheel and the axle box.

Mr. W. B. Adams thought that some good plan was certainly much wanted, for efficiently closing the back of the axle box, and there was not such a one in use at present; he thought the three or four inches space now usually left between the nave and axle box would be sufficient for the introduction of the proposed conical spring.

The Chairman observed that it was a very important point to get the grit thoroughly shut out, and a good combination might perhaps be made of some of the plans that had been proposed for the purpose; any experiments on lubrication were interfered with in the results by the entrance of grit.

Mr. W. B. Adams remarked the difficulty of making exactly parallel experiments on the lubrication of railway axles, from the number of disturbing circumstances, in the variation of weight and uniformity of bearing on the journals, and in the attention to the lubrication, and the difficulty of getting the exact mileage.

Mr. Lea suggested the experiments to be made at the same time on opposite sides of the same carriage, so as to have them under similar circumstances.

The Chairman said he hoped Mr. Adams would pursue the subject, and give them further results; and he proposed a vote of thanks to him for his paper, which was passed.

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*American Legislation for Railways.**

The following appears in an American paper:—

"*Hartford, June* 9.—The committee on railroads have reported to the Legislature of Connecticut a bill which provides that all trains shall come to a full stop at all drawbridges, and wherever the track crosses that of other roads. It attaches heavy penalties for every instance of these regulations being disregarded. The engineers are to be fined and imprisoned, and the President or Directors being parties thereto shall be fined $1000. It also requires men to be stationed at all the switches under similar penalties, and where the speed is over 30 miles per hour a brakesman is required for every car, under a penalty of $1000. Engineers neglecting to stop the train when persons are seen upon the track are to be deemed guilty of manslaughter, if such persons are killed. The Presidents of all roads within the State must reside within its boundaries, and the officers of roads out of the State are not to be allowed to hold any offices upon roads in the State, under a penalty of $1000 per day."

In the state of Illinois a fine of $5000 or £1000 is imposed for every death caused by a railway.

Such regulations may do for America, but would by no means suit England. We do not say this with respect to the fines and imprisonments on the engine driver in case of accidents through disobedience of orders or carelessness, nor to the fining of Directors when parties thereto, nor to fining officers for holding situations on more lines than one; but to make trains come to rest at all crossings of other roads and when persons are seen on the line, would in England be preposterous. They would hardly ever get to the end of the journey on some railways in the north; and as to express trains, it would put an extinguisher on them at once. Again, to stick a man at every switch all day long is nonsense. The fellow would fall asleep if he had not something else to do. A brakesman to every carriage when the speed exceeds 30 miles an hour shows two things, the little knowledge the framers of the bill must have of railways, and the comparatively slow speed at which the American trains travel. If they were to go like some of our express trains at 60 miles an hour, we presume they would have two or three brakesmen at every carriage, and possibly one for every wheel.

*From Herapath's Journal, No. 734.

For the Journal of the Franklin Institute.

Experiments on Screw Propellers in H. B. M. Steamer Minx. By B. F. Isherwood, Chief Eng., U. S. N.

(Continued from page 226.)

Screws of Expanding Pitch Fore and Aft, but of Uniform Pitch Radially.

Two screws were experimented with, having their pitches expanding from fore to aft, but uniform radially. They were two-bladed screws of 4 feet 6 inches diameter, and 12 inches length. Their mean pitches were designed to be respectively 5 feet, and 5 feet 6 inches. With the screw having the mean pitch of 5 feet 6 inches two experiments were made, which were so greatly inconsistent with the general results that I reject them.

With the screw of 5 feet mean pitch, which I shall call screw D, three trials were made, giving results closely agreeing with each other and consistent with the general results; I therefore accept them. The initial pitch of this screw was 4 feet 10 inches; the final pitch, 5 feet 2 inches; the rate of expansion being 7 per centum of the initial pitch. The mean pitch being 5 feet, this screw was in all respects the same as screw C, of the series of uniform pitch.

The slip of screw C was 31·6 per centum; that of screw D (calculated for the mean pitch of 5 feet, same as for screw C,) was 26·2 per centum, showing a reduction in the slip of 5·4 per centum absolutely, or $\left(\frac{31{\cdot}6 - 26{\cdot}2 \times 100}{31{\cdot}6} = \right)$ 17·1 per centum relatively, by the employment of the expanding pitch. With screw C, a speed of 8·576 geographical miles per hour was obtained with 205·56 horses power. With screw D, a speed of 8·615 geographical miles per hour was obtained with 193·34 horses power. The relative economical efficiencies of the two screws will therefore be as follows:

	Powers.	Speeds.	Effects.	Relative economical efficiencies.
Screw C.	205·56 or 1·0000	8·576 or 1·0000 and $1{\cdot}0000^3 = 1{\cdot}0000$	and $\frac{1{\cdot}0000}{1{\cdot}0000} = 1{\cdot}0000$.	
Screw D.	193·34 or 0·9405	8·615 or 1·0045 and $1{\cdot}0045^3 = 1{\cdot}0136$	and $\frac{1{\cdot}0136}{0{\cdot}9405} = 1{\cdot}0777$.	

Whence appears, that in the cases of the two screws, having equal diameters, number of blades, and surfaces, the uniform pitch of one and the mean of the expanding pitch of the other being the same, the power was 1 0777 times better applied by the screw with the expanding pitch than by the screw with the uniform pitch. With the screw of expanding pitch a reduced slip of 5·40 per centum, (calculated for the mean pitch,) gave an increased efficiency of 7·77 per centum, and as the screw surface was equal in the two cases, the superiority must have arisen from the difference in the slip.

To further illustrate the effect of the expanding pitch, screw D was reversed on its shaft, and a trial made. By this reversal, the screw was

changed end for end, the greater pitch becoming the initial one, and the lesser pitch the final one. The slip, calculated for the same mean pitch (5 feet) as before, was now 39·9 per centum, or $(39{\cdot}9 - 26{\cdot}2 =)$ 13·7 per centum absolutely more than before, or $\left(\frac{39{\cdot}9 - 26{\cdot}2 \times 100}{26{\cdot}2} =\right)$ 52·7 per centum relatively more than before. In this condition of things, a speed of 6·628 geographical miles per hour was obtained with 148·94 horses power. With screw D, or this screw in its normal position, a speed of 8·615 geographical miles per hour was obtained with 193·34 horses power. The relative economical efficiency of the screw in the two positions will therefore be as follows:

Normal Position.

	Powers.	Speeds.	Effects.	Relative economical efficiencies.
Screw D.	193·34 or 1·2981	8·615 or 1·3004 and $1{\cdot}3004^3 = 2{\cdot}1990$	and	$\frac{2{\cdot}1990}{1{\cdot}2981} = 1{\cdot}6940.$

Reversed Position.

Screw D.	148·94 or 1·0000	6·625 or 1·0000 and $1{\cdot}0000^3 = 1{\cdot}0000$	and	$\frac{1{\cdot}0000}{1{\cdot}0000} = 1{\cdot}0000.$

Whence appears that the power was 69·4 per centum better applied by the screw in its normal than in its reversed position.

The following table exhibits in detail, the data and results of the screw D, with expanding pitch fore and aft, but uniform pitch radially:

	Vessel's draft of water in ft. and in.			SCREW.												ENGINES.			
	Forward.	Aft.	Mean.	Diameter in ft. and ins.	Vessels draft of water in ft. and inches. Initial.	Mean.	Final.	Number of blades.	Helicoidal area in square feet.	Length in direction of axis in inches.	Number of revolutions made per minute.	Slips of the screws in per cents. of its speed. Of initial pitch.	Of mean pitch.	Of final pitch.	Gross average pressures in the cylinders in lbs. per square inch.	Number of double strokes of engines' pistons made per minute.	Horses power developed by the engines.	Speed of the vessel per hour in knots of one statute mile.
										Screw D.								
*	4 6½	5 10½	....	4 6	4 10	5 0	5	2	2	7·2	12	217·2	22·1	24·7	27·1	9·52	54·29	....	8·069
†	4 5	6 1	....	4 6	4 10	5 0	5	2	2	7·2	12	254·1	24·6	27·1	29·4	12·19	63·53	....	9·137
‡	4 5	6 0	....	4 6	4 10	5 0	5	2	2	7·2	12	238·5	24·0	26·6	28·9	10·71	59·63	....	8·640
§	4 5½	5 11½	5 2⅝	4 6	4 10	5 0	5	2	2	7·2	12	236·6	23·7	26·2	28·6	10·8	59·15	193·34	8·615
										Screw D, reversed.								
‖	4 6½	5 10½	5 2½	4 6	5 5	5 0	4 10	2	7·2	12	223·4	41·8	39·9	37·8	8·81	55·86	148·94	6·625

*July 8th, 1847. †July 1st, 1848. ‡July 12th, 1848. §Means. ‖August 17th, 1847.

Screws of Expanding Pitch Radially, but of Uniform Pitch Fore and Aft.—Three screws were tried, having their pitches uniform fore and aft, but expanding radially; that is, from the hub to the periphery. These screws were 4 feet 6 inches diameter, two-bladed, and 12 inches long, being similar screws in all other respects than pitch to those previously discussed. One of these screws having a pitch of 4 feet at the hub, and 5 feet at the periphery, was tried twice, once August 11th, and again September 18th, 1847, but the results are so inconsistent that I reject them. The remaining two screws I shall call respectively E and F.

With screw E two trials were made, and as the results closely agree, and are consistent with the general results, I accept them. This screw had a pitch of 4 feet 10 inches at the hub, and 5 feet 4 inches at the periphery, the rate of expansion being 10·3 per centum of the pitch at the hub. As the exact configuration of the screw is not given, the mean pitch cannot be *exactly* determined, but it is approximately 5·10 feet in function of surface, and of the square of the circumferential velocity of the surface: this determination I believe to be more than sufficiently accurate for practical results. It will be observed that screw E almost exactly corresponds to screw C, of the screws with uniform pitches, having the same diameter, number of blades, length and surface, and differing but slightly in its mean pitch, which is 5·10 feet, from the uniform pitch of screw C, which is 5 feet. The two screws may, therefore, be considered identical. With screw C, the slip was 31·6 per centum; with screw F, the slip was also 31.6 per centum, exactly the same, and showing that a screw with the pitch expanding radially from hub to periphery, produces the same result as a true screw, or screw of uniform pitch, when the diameter, number of blades, surface and *mean* pitch were the same with the one, as the diameter, number of blades, surface and uniform pitch with the other.

With screw F, three trials were made, and as the results closely agree with each other, and are consistent with the general results, I accept them. This screw had a pitch at the hub of 4 feet 3 inches, and at the periphery, of 6 feet 3 inches, being a rate of expansion of 47 per cent. over the pitch at the hub. The mean pitch, as approximately but closely determined, is 5·80 feet. It will be observed that this screw, F, almost exactly corresponds to screw A of the series with uniform pitch, having the same diameter, number of blades, length and surface, and differing but very slightly in its mean pitch, which is 5·80 feet, from the uniform pitch of A, which is 5·83 feet. The two screws may, therefore, be considered as identical. With screw A, the slip was 37·3 per centum; with screw F, the slip was 36·9 per centum, differing but four-tenths of one per centum. The result in this case verifies the proposition in the preceding paragraph, that equal results are produced by screws of equal diameter, number of blades, length and surface, and differing but in the nature of the pitch, which in the one is uniform, and in the other expanding radially, but having the mean pitch of the latter equal to the uniform pitch of the former.

In proceeding to ascertain the relative economical efficiency of screws E and F, comparatively to screws C and A, by taking the horses power developed by the engines in the several cases, for the measure of the power exerted, and the cubes of the vessel's speed for the measure of the effects produced, it is necessary to make a correction of what is given as the indicated gross pressure in the cylinders in the case of screw E, which pressure is obviously greatly incorrect. In the two trials with that screw, this pressure is respectively 9·42 and 9·41 pounds per square inch, mean 9·415 pounds, for 53·40 and 56·71 double strokes of engines' pistons, mean 55·06 double strokes; while for screw C, the average gross pressure in the cylinders is 10·7 pounds per square inch, with 63·48 double strokes of pistons. These latter numbers being consistent with the gene-

ral results throughout the experiments, are taken to be correct, and as with the same screw propelling the same vessel under the same conditions, the piston pressures will be in the proportion of the squares of the number of double strokes of piston made in equal times; the piston pressure in the case of screw B, will be $(63{\cdot}48^2 : 10{\cdot}7 :: 55{\cdot}06^2 : 8{\cdot}051)$ 8·051 pounds per square inch, which increased in the ratio of 5·1 to 5·0 for the different pitches becomes 8·212 pounds; this number is, therefore, substituted for the pressure, 9·415 pounds, and the horses power calculated from it. With this correction the relative economical efficiency of the screws will compare as follows:

	Powers.	Speeds.	Effects.	Relative economical efficiencies.
Screw E.	136·84 or 1·0000	7·575 or 1·0000 and $1{\cdot}0000^3 = 1{\cdot}0000$ and	$\frac{1{\cdot}0000}{1{\cdot}0000} = 1{\cdot}0000$.	
" C.	205·56 or 1·5022	8·576 or 1·1321 and $1{\cdot}1321^3 = 1{\cdot}4510$ and	$\frac{1{\cdot}4510}{1{\cdot}5022} = 0{\cdot}9659$.	
" F.	176·65 or 1·0000	8·018 or 1·0000 and $1{\cdot}0000^3 = 1{\cdot}0000$ and	$\frac{1{\cdot}0000}{1{\cdot}0000} = 1{\cdot}0000$.	
" A.	197·42 or 1·1176	8·325 or 1·0383 and $1{\cdot}0383^3 = 1{\cdot}1194$ and	$\frac{1{\cdot}1194}{1{\cdot}1176} = 1{\cdot}0016$.	

It will be observed that the relative economical efficiencies of the screws F and A, appear, as they should do, sensibly equal; while there is a slight discrepancy in what should be the equal economical efficiency of screws E and C; but in the case of screw E, there remains some doubt as to the piston pressure which is obtained by induction from the piston pressure of screw C; the discrepancy, however, is but little. The equal results thus obtained verify the equality previously inferred from the equal slips of the screws.

The following table exhibits in detail the data and results of the screws of expanding pitch radially, but of uniform pitch fore and aft:

	Vessel's draft of water in ft. and in.			SCREW.												ENGINES.			
	Forward.	Aft.	Mean.	Diameter in ft. and in.	Pitches in feet and ins. At hub.	Pitches in feet and ins. Mean.	Pitches in feet and ins. At periphery.	Number of blades.	Helicoidal area in square feet.	Length in direction of axis in inches.	Number of revolutions made per minute.	Slips of the screw in per cents. of its speed. Of pitch at hub.	Slips of the screw in per cents. of its speed. Of mean pitch.	Slips of the screw in per cents. of its speed. Of pitch at periphery.	Gross average pressure in the cylinders in lbs. per square inch.	Number of double strokes of engines' pistons made per minute.	Horses power developed by the engines.	Speed of the vessel per hour in geographical miles of 69⅓ feet.
*	4 6½	5 10½	....	4 6	4 10·5	11⅛	5 4	2	7·3	12	213·6	26·9	30·7	33·8	....	53·40	....	7·442
	4 6½	5 10½	....	4 6	4 10·5	11⅛	5 4	2	7·3	12	226·8	28·6	32·4	35·4	....	56·71	....	7·708
	4 6½	5 10½	5 2½	4 6	4 10·5	11⅛	5 4	2	7·3	12	220·2	27·8	31·6	34·6	8·212	55·06	136·84	7·575
†	4 7	5 11	....	4 6	4 3·5	9⅝	6 3	2	7·5	12	216·6	12·4	35·8	40·4	10·34	54·15	....	7·957
	4 6½	5 10½	....	4 6	4 3·5	9⅝	6 3	2	7·5	12	226·4	14·8	37·6	42·1	10·18	56·60	....	8·083
	4 6½	5 11	....	4 6	4 3·5	9⅝	6 3	2	7·5	12	224·0	14·6	37·3	42·0	10·99	756·01	....	8·014
	4 6⅔	5 10⅝	5 2¾	4 6	4 3·5	9⅝	6 3	2	7·5	12	222·3	13·9	36·9	41·5	10·5	55·59	176·65	8·018

* Screw E. { August 11, 1847. Sept. 18, "

† Screw F. { September 4th, 1847. " 18th, " October 14th, "

Screw of Expanding Pitch both Fore and Aft and Radially.—With a view to complete the series of experiments, a screw was tried having an uniform pitch at the hub of 4 feet 3 inches, expanding radially to the

periphery. The pitch also (except immediately at the hub,) expanded from fore to aft, the initial pitch at the periphery being 5 feet 6 inches, expanding to a final pitch of 7 feet, making the mean pitch at the periphery 6 feet 3 inches, and the ratio of expansion 21·4 per centum of the initial pitch. The rate of expansion from hub to periphery, calculated for the above mean pitch, was 47 per centum of the pitch at the hub. The mean pitch of the entire screw blade in function of surface, and of the square of the circumferential velocity of the surface, was 5·80 feet. This screw, which I shall call G, was 4 feet 6 inches in diameter, two-bladed, and 12 inches long; it was equal to screw F in all respects, except in the fore and aft expansion of the pitch; but the mean pitches of both screws were the same, viz: 5·80 feet.

With screw G two trials were made, the results of which are consistent with each other, and with the general results. The mean slip as given by these trials was 33·4 per centum; the mean slip of screw F was 36·9 per centum, or the slip of screw G was 3·5 per centum absolutely, or $\left(\frac{36{\cdot}9 - 33{\cdot}4 \times 100}{36{\cdot}9} = \right)$ 9·49 per centum relatively less. This difference in the slip is to be attributed to the expanding pitch fore and aft, and corroborates the comparative results from screw C of uniform pitch, and screw D of expanding pitch fore and aft. The relative economical efficiencies of screws F and G will appear from the following:

	Powers.	Speeds.	Effects.	Relative economical efficiencies.
Screw F.	176·65 or 1·0000	8·018 or 1·0000	and $1{\cdot}0000^3 = 1{\cdot}0000$ and	$\frac{1{\cdot}0000}{1{\cdot}0000} = 1{\cdot}0000$.
Screw G.	181·39 or 1·0268	8·203 or 1·0231	and $1{\cdot}0231^3 = 1{\cdot}0706$ and	$\frac{1{\cdot}0706}{1{\cdot}0268} = 1{\cdot}0427$.

Whence appears that with a screw of expanding pitch, a decrease of slip of 3·5 per centum (calculated for the mean pitch,) gives an increased efficiency of 4·3 per centum. Allowing for unavoidable slight errors of data, the increased efficiency was probably in the direct ratio of the decreased slip.

The following table exhibits in detail the data and results of the screw with expanding pitch both fore and aft and radially:

Vessel's draft of water in ft. and in.†		SCREW.										ENGINES.			
Forward.	Aft.	Diameter in feet and ins.	Pitches in feet and inches. At the hub.	Initial at the periphery.	Final at the periphery.	Mean for the whole screw.	Number of blades.	Helicoidal area in square feet.	Length in direction of axis in inches.	Number of revolutions made per minute.	Slip of the screw in per cents. of its speed. Of pitch at the hub.	Of initial pitch at periphery.	Of final pitch at periphery.	Of mean pitch for whole screw.	Gross average pressure in the cylinders in lbs. per square inch.	Number of double strokes of engines' pistons made per minute.	Horses power developed by the engines.	Speed of the vessel per hour in geographical miles of 6082⅔ feet.
*4 6½	5 11	4 6	4 3·5	6 7·0	5 9⅝		2	5·95	9	214·2	10·9	31·1	45·9	34·7	11·33	53·55	.....	8·001
4 3	6 1	4 6	4 3·5	6 7·0	5 9⅞		2	5·95	9	216·6	7·4	28·5	43·8	32·2	10·93	54·16	.....	8·406
4 4¾	6 0	4 6	4 3·5	6 7·0	5 9⅝		2	5·95	9	215·4	9·1	29·8	44·8	33·4	11·13	53·85	181·39	8·203

* Screw G. { October 14th, 1847. / June 30th, 1848. † Mean of forward and aft, 5 feet 2⅝ inches.

The following table contains a general summary of the data and re-

sults of the experiments. With screws of expanding pitches, only the mean pitch and slip corresponding to it are given. The quantities marked with a star (*) are doubtful. I am decidedly of the opinion that with screws of greater pitch and length than those experimented with, the gain obtained by the use of the expanding pitch fore and aft, would be much greater than is shown in the table.

General Summary of the Experiments.

Designation of screw.	Number of trials.	Vessel's draft of water in ft. and in.			SCREW.							ENGINES.			Speed of the vessel per hour in knots of 6082⅔ feet.	Relative economical efficiency of the screws in function of p'e' exerted, & cube of spd. obt'd.
		Forward.	Aft.	Mean.	Diameter in feet and inches.	Pitch in feet and in.	Number of blades.	Helicoidal area in sq. feet.	Length in direction of axis in inches.	Number of revolutions made per min.	Slip of the screw in per cts. of its speed.	Gross average press. in the cylinders in lbs. per sq. in.	No. of double strokes of engines' pistons made per minute.	Horses power developed by the engines.		
Screw of Uniform Pitch.																
A.	4	4 5½	5 11½	5 2¾	4·6	5 10	2	7·10	12	230·9	37·3	11·3	57·73	197·42	8·325	1·0000
1st Mod. A.	3	5 6½	5 11	5 2½	4·6	5 10	2	5·97	10	233·3	39·6	10·4	58·32	183·56	8·110	0·9942
2d "	1	4 6½	5 10½	5 2½	4·6	5 10	2	4·93	8	237·8	41·7	9·01	59·45	178·30	7·972	0·9722
B.	1	4 5	6 0	5 2½	4·6	5 6	2	7·10	12	240·6	34·8	11·44	60·14	207·48	8·514	1·0182
C.	3	4 5½	5 11½	5 2⅝	4·6	5 0	2	7·20	12	254·0	31·6	10·7	63·48	205·56	8·576	1·0498
Screws of Expanding Pitch Fore and Aft, but of Uniform Pitch Radially.																
D.	3	4 5½	5 11⅞	5 2¾	4·6	5 0	2	7·20	12	236·6	26·2	10·8	59·15	193·34	8·615	1·1306
D reversed.	1	4 6½	5 10¼	5 2½	4·6	5 0	2	7·20	12	223·4	39·9	8·81	55·86	148·94	6·625	0·6689
Screws of Expanding Pitch Radially, but of Uniform Pitch Fore and Aft.																
E.	2	4 6¼	5 10¼	5 2¼	4·6	5 1⅛	2	7·30	12	220·2	31·6	8·212	55·06	136·84*	7·575	1·0868*
F.	3	5 2⅝	5 10⅝	5 2¾	4·6	5 9⅜	2	7·50	12	222·3	36·9	10·5	55·59	176·65	8·018	0·9983
Screws of Expanding Pitch both Fore and Aft and Radially.																
G.	2	4 4¾	6 0	5 2⅜	4·6	5 9⅜	2	5·95	9	215·4	33·4	11·13	53·85	181·39	8·203	1·0410

General Conclusions.—From the foregoing experiments, the following are the general conclusions arrived at:—

1st, That with screws the same in all respects, except amount of pitch, the slip is in the simple ratio of the pitch, the greater pitch giving the greater slip; also, that the economical efficiency of the screw is in the simple inverse ratio of its pitch, the lesser pitch giving the greater efficiency.

2d, That the reduction of the surface of the same screw by cutting off portions by a plane passing through it perpendicular to the axis, is attended (within the limits experimented on) by an increase of slip, and by a decrease of economical efficiency.

3d, That with screws the same in all respects, except kind of pitch, the one having an uniform pitch throughout, the other having a pitch uniform radially, but expanding fore and aft, the mean pitch, however, being the same as that of the screw of uniform, the screw of expanding pitch has the less slip, and its economical efficiency is greater in proportion to the lessened slip.

4th, That with screws the same in all respects, except kind of pitch, the one having an uniform pitch throughout, the other having a pitch uniform fore and aft, but expanding radially from hub to periphery, the mean

pitch, however, being the same as that of the screw of uniform pitch, the slip is the same, and the economical efficiency is the same in both cases. Consequently, there is neither advantage nor disadvantage in using a screw with a pitch expanding radially from the hub to the periphery.

5th, That slip is a measure of the loss of power for producing useful effect; that it *causes* a loss of the total power developed by the engines equal to its per centage.

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*Locomotive Expenses on the Eastern Counties Railway.**

The number of miles run by the trains on this line, during the last half-year, was 1,625,274; the cost of working, £67,309; and the miles of railway worked, 434¼. And in the corresponding period of 1850, 1,185,628 miles were run; the cost of working, £85,070; and the length of railway worked, 327¾ miles. Showing an increase, in the length of railway worked, of 106½ miles; in the number of miles run, of 439,646 miles; and a decrease in the working expenses, of £17,761. The average cost of working, in the half-year ending the 4th of July, 1850, was 17·22*d.* per mile per train, including 13·89*d.* for locomotive power; and in the half-year ending the 4th of July last, the cost of working was 9·94*d.* per mile per train, including 7·88*d.* for locomotive power. Comparing the cost of working per mile per train in 1850, with that of 1853, a saving of £49,306 is shown on the half-year ending the 4th of July last. The increase in the number of miles run by the trains over that of the half-year ending the 4th of July, 1852, was 152,164 miles, attended by an actual decrease of expenditure of £894.

Simple Means of Preventing the Formation of Incrustations in Boilers.

By R. Fresenius.†

It has been found, since 1851, that no incrustation was formed in the boiler of a steam engine at Ems, whilst the water with which the boiler was supplied contained 21·899 grs. in the pound of solid matters. These were—

	grs.
Carbonate of soda,	11·35488
Sulphate of soda,	0·10790
Chloride of sodium,	7·27020
Sulphate of potash,	0·43653
Carbonate of lime,	1·24370
Carbonate of baryta,	1·06890
Carbonate of iron,	0·01728
Carbonate of manganese,	0·00868
Carbonate of baryta and strontian,	0·00215
Phosphate of alumina,	0·01090
Silica,	0·37839
	21·89951

From this Fresenius concludes that it is not carbonate of lime, but only

* From the London Practical Mechanic's Journal, September, 1853.
† From the London Chemical Gazette, No. 261.

sulphate of lime which causes the formation of crust, and that in the present case this is prevented by the quantity of soda contained in the water. This has given occasion to investigations, in which soda was added to water containing sulphate of lime, which hitherto had always deposited incrustations. In these cases the action was always found successful, so that Fresenius regards the addition of soda as the simplest means for the prevention of incrustation.

The author gives the following rule to prevent the addition of soda in excess:—100 parts of anhydrous sulphate of lime are decomposed by 78 parts of pure calcined soda. The discovery of the correct quantity is so simple and easy, that this circumstance does not present the least difficulty. Care must be taken that there be always a slight excess of soda present, and the water in the boiler must therefore be tested from time to time. This is better and more accurately effected than with test-paper, by dividing a sample (filtered if necessary) of the water of the boiler into two parts, and adding to one part solution of soda, to the other lime water. If the former remains clear whilst the other is rendered slightly turbid, the proportion is correct. If the reverse is the case, soda must be added, whilst its quantity can be diminished if the turbidity with lime water be very great.—*Journ. für Prakt. Chem.*, lviii. p. 65.

On the Analysis of the Gases from the Furnaces of Locomotives. By M. Sauvage, *Ingenieur-en-Chéf des Mines.**

[Extract from a Necrological Notice of M. Ebelmen.]

[We are indebted to the courtesy of a correspondent for the following paper, which will be of great interest to our readers after the report of Mr. D. K. Clark's paper "On the Principles of Locomotive Boilers," and the discussion thereon at the Institution of Civil Engineers, which has appeared in our pages. M. Ebelmen was, perhaps, of all others, the man best qualified to conduct the investigation, having for years dedicated himself to the analysis of the products of combustion in different furnaces. Our correspondent remarks that "the scientific deductions from experiment prove that Mr. Stephenson and those who supported his *opinion* were right, and that Mr. McConnell has applied his ingenuity in the *wrong direction*. It is clear that, properly constructed, *express engines* require no additional contrivance for consuming carbonic oxide, for there is none generated in the fire boxes of such engines."—Ed.]

Ebelmen, with myself as coadjutor, undertook a series of experiments, the object of which was the analysis of the gases issuing from the furnace of the locomotive engine. The results obtained from a considerable number of analyses prove the possibility of establishing a definite theory of this important class of furnaces, which have hitherto been constructed upon notions often contradictory. We have quite clearly proved that these furnaces are much more perfect than they are generally believed to be, and that the combustion is much more complete in the furnace of a locomotive than in that of any fixed engine.

* From the London Artizan, August, 1853.

The experiments were made on each of the three types of engine used on the Lyons Railway, viz:—

Passenger engine—not coupled.

Mixed traffic engine—4-wheel, coupled.

Goods engine—6-wheel, coupled.

The composition and nature of the gases varies, necessarily, with the quantity of air which passes through the fire; and this quantity depends, as we know, on the tension of the steam at the escape of blast pipe.

The proportion of carbonic acid contained in the gases of the locomotive is greater than is contained in the gases from ordinary fixed-engine furnaces; whilst the proportion of free oxygen corresponding to the excess of air in the draft is *less* from the locomotive furnace, a result clearly proving that there is a greater useful effect obtained from the fuel.

In the experiments on the passenger engines, and on the mixed traffic engines, the proportion of carbonic acid rose from 12·42 to 18·49 per cent. of the volume of gas, without there being any production of carbonic oxide. The higher per centage represents a result approximating very remarkably to the number 20·80, which represents the proportion of carbonic acid in the case of combustion *theoretically perfect*, or in which *all the oxygen* would be converted into carbonic acid.

The combustion in passenger engines is almost perfect, and in the mixed engine, provided the fire is attended to by an experienced stoker, it is nearly as good. These furnaces produce little or no carbonic oxide; the proportion of this gas rarely exceeds 2 per cent.

The goods engines, the grates of which are often charged with a great depth of coke, produce a greater amount of carbonic oxide. The quantity rose as high as 7·58 per cent., when the fire was 40 inches deep.

The composition of the gas varied according to the range of tube from which it was collected. It would certainly be possible to adopt arrangements which would permit of this carbonic oxide being usefully burnt, and thus improve the useful effect of the fuel in these engines.

During the stoppages of locomotives, or after the shutting of the regulator, the gases have a larger proportion still of carbonic oxide. It gets as high as 12 per cent. of the volume.

These results are quite in accordance with practical experience in reference to the consumption of fuel in these different engines. They indicate a limit of the depth of fire which it is wrong to exceed, and also what amount of economy can be effected by the intelligent employment of expansion and variable blast pipes, according to the depth of the fuel in the fire.

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*Railway Chairs.**

A gentleman who has seen Mr. Norris's patented method of chairing the rails on the London and North Western Railway describes it to us thus. He says it consists of a traveling furnace containing the melted iron, with a bellows to keep the fire up. Where there is a defective chair or a new one wanted, the old one is removed or broken off with the blow

*From Herapath's Journal, No. 732.

of a hammer, and the mould (which we presume must be in two parts) placed under the rail as it lies, the liquid iron is poured into it, and a new chair formed almost while one can say "Jack Robinson." As the iron of the new chair cools, it contracts and clips the rail with a grip much tighter than the present method of keying it. The iron of the old chair cast into the pot and remelted becomes material for a new chair. Thus a long length of line may be new chaired without any load of material or disturbance of the rails, and in a very short time.

We have not seen this process, and therefore can give no opinion of it; but taking it as described, there must be some provision at the rail joints for preventing the molten iron from getting between the ends of the two rails; for if not, by any great increase of temperature the whole line would burst up by the expansion of the rails.

AMERICAN PATENTS.

List of American Patents which issued from September 13, to October 11, 1853, (inclusive,) with Exemplifications by CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

SEPTEMBER 13.

24. For *Improvements in the Gear of Variable Cut-off Valves for Steam Engines;* Matthias W. Baldwin, Philadelphia, Pennsylvania.

"The principle of varying the cut-off by means of a vibrating arm and sliding pivot block has long been known, but the contrivances for changing the position of the block upon the arm have been very defective. The radius of motion of the link by which the sliding block is changed on the arm, the radius of motion of that part of the vibrating arm on which the block is placed, have in this kind of valve gear, as heretofore constructed, been different, which produced a continual rubbing of the sliding block upon the arm while the arm is vibrating, and as the block for the greater part of the time occupies one position on the arm, and only has to be moved towards either extreme occasionally, that part of the arm on which the block is most used soon becomes so worn that the block is loose, and jars. This can only be remedied by dressing up the arm throughout its entire length; for if the brasses of the block were set up so as to make the block fit on the narrow portion of the arm, it could not be moved towards the extremes. To remedy these defects in the link motion, has long been a desideratum. The plan, however, of most engines now built, does not admit of the position of the parts of the old motion being so disposed as to avoid the difficulties specified, while my improvement can with the greatest facility be applied to any of them. This contrivance I have essayed, and find that it works well in practice, overcoming all the difficulties incident to the use of the numerous other gearing for variable cut-off valves of which I have a knowledge, and because of the superiority of this device in practice, I desire to patent it."

Claim.—"The arrangement of the sliding pivot block, fitted with a stem, connected with the sector by straps, chains, or cogs, the hand lever, and the intermediate connecting mechanism, as herein described."

25. For an *Improvement in India Rubber Soles for Boots and Shoes;* John Chilcott and Robert Snell, Brooklyn, New York.

"The nature of our invention consists in making the sole of three parts, viz: the india rubber sole, a leather lining, and a leather border."

Claim.—"What we claim is, constructing the whole or any portion of the sole of a boot or shoe, substantially as described, of india rubber, with its inside and edges covered and protected by leather, which is united with it by any water proof cement, with or without stitching, and forms a hard, firm, leather edge."

26. For an *Improvement in Cutting Boots and Shoes;* John Chilcott and Robert Snell, Brooklyn, N. Y.; patented in Belgium, Sept. 16, 1852; in France, Sept. 17, 1852; in England, Sept. 30, 1852.

"Our invention consists in a certain new method of cutting out, or otherwise forming a piece of leather or other material, so that it may be folded, without crimping and without the addition of gussets or other pieces, to take the required form of what is commonly termed the 'upper leather' of a boot, to fit any foot, heel, and leg, not positively deformed, with the greatest accuracy."

Claim.—"Having thus described the nature of our invention, and the manner in which we have used the same with perfect success, we do not claim the manufacture of boots without crimping; but what we do claim is, the form of the piece of leather or other material, substantially as shown and herein described, by which we are enabled to make what is termed the 'upper leather' of a boot to fit any leg, foot, and heel, not absolutely deformed, of one piece, without crimping or joining other pieces thereto; the distinguishing characteristics of this form being that one-half or side of the boot is formed by a part without joint, and the other half or side by the junction of a part folded from the back of the side, and a part which is partly cut from, or which when flat lays close or near to the front above the instep, and partly folded over from the instep; the part being of such form as to form one side of the foot, and extend round the heel to the other side, and cover an opening made in the lower part of the back, to give the required form to the heel, and also to make part or all of the necessary stiffening."

27. For an *Improvement in Bed Bottoms;* Pierre Demeure and Auguste Mauritz, City of New York.

"Our invention consists in an improved construction of spring bed bottoms, and bedsteads in combination therewith. The improvement in the spring bottom consists in giving elasticity transversely in combination with the vertical action of the spiral springs."

Claim.—"What we claim is, the manner of constructing the spring mattress by combining the vertical springs with an elastic spring network of spiral metallic springs, for supporting said vertical springs, or for increasing the elasticity, so that a person lying upon the bedside will be equally supported on all sides, as described."

28. For an *Improvement in the Shape of Scythes;* William P. Greenleaf, Washington, New Hampshire.

Claim.—"What I claim is, widening and curving the blade of the scythe at the shank, in the manner described, for the purpose of strengthening the same, and adapting it to cutting bushes as well as grass."

29. For an *Improvement in Safety Valves for Steam Boilers;* Zadoc H. Mann, Cincinnati, Ohio.

"My invention has for its object an increase of sensibility of the safety valve, so as to insure its opening at the desired maximum of pressure; and also so as to increase the size of opening in proportion to the force of steam, and thus insure an adequate vent for the steam under all circumstances, and thereby remove all danger or possibility of explosion with a suitable boiler."

Claim.—"What I claim is, the construction and application to a safety valve, of flutter wheel, governor, and supplementary lever, as described, or equivalent devices, in order to insure promptness of action, and an increase of vent, according to the force of steam; and this I claim either with or without the adjustable link and counter-weight, as described."

30. For an *Improved Revolving Mandrel for lining Cylinders with Metal;* George Potts, Cincinnati, Ohio.

"The object of my invention is, the production or manufacture of a pump, or other cylinder having a lining or interior casing of sheet copper, and the peculiar feature of novelty exists in devices for the application of said casing in such a manner as to give to the interior of the barrel a smooth, dense, and truly cylindrical surface, superseding the necessity of, and superior in its result to the fine boring and grinding now requisite."

Claim.—"What I claim is, the revolving mandrel, furnished with one or more rollers, whose distance from the axis of the mandrel can be increased or diminished by means of a nut, sleeve, and conical head, as described, or any equivalent device, for the purpose herein explained, of lining with one metal the interior of a cylinder formed of another metal."

31. For an *Improvement in the mode of Bucking Cloth;* Andrew Robeson, Jr., Newport, R. I.; patented in England, November 8, 1852.

"In my improved method of bowking, the pressure of the steam is not only employed to saturate the goods, but to assist and increase the filtration of the bowking liquor through them. The experiments I have performed have led me to discover by the use of my apparatus, a very great saving of time and labor in the bowking of cloth. I am led to believe that there will be not only a saving of at least fifty per cent. in time, but there will be a great saving in fuel over the common processes of bowking."

Claim.—"What I claim is, the employment of a closed kier or vessel, above described, and extracting the bowking liquor from the lower part of it, and forcing it into the upper part of it, while steam is being injected only into the upper part of the said vessel, and on the top of the goods, whereby, while the bowking liquor is being thrown on the top of the mass of goods, the steam is constantly and simultaneously made to press upon and pass into and through the goods, and facilitate the action of the bowking liquor, and its passage through the cloth, as stated."

32. For an *Improvement in Fences;* Hervey S. Ross, Cincinnati, Ohio.

"Two prominent objects of utility in my invention are its adaptation to situations exposed to heavy floods, and the easy removal of the fence from one place to another."

Claim.—"What I claim is, the herein described zigzag and interlocked arrangement of panels, supported by a swivel joint to posts at suitable intervals, and having the joint between the two middle panels furnished with inclined hook and eye, each of said middle panels being provided with boards sloping in opposite directions, so that by the action of a flood, each half of the intervening line of panels may separate midway, and swing in the direction of the current, or devices substantially equivalent."

33. For an *Improvement in Boot Jacks;* Samuel B. Sumner, Grantville, Massachusetts.

Claim.—"What I claim is, the application to an instrument for taking off boots, of the side bars, the shaft, and the bar, arranged and operating in the manner substantially as described."

34. For an *Improved Cutter Head for Moulding Machines;* Josiah M. Smith, City of New York.

"My invention consists in an improvement in the construction of cutter heads, for cutting mouldings in wood, marble, and other like materials. The object designed to be accomplished by me is the ability to put, and afterwards keep in order, the cutting edges of the series of chisels."

Claim.—"What I claim is, the combination of the slotted supporting flanches, or their equivalents, with the chisels, hinged and operated in the manner and for the purposes substantially as set forth herein."

35. For *Improvements in working the Valves of Steam Engines;* Richard H. Townsend, City of New York.

"The nature of my invention consists in a peculiar combination of the eccentric and cam, the eccentric working as usual when operating on the valve to give the engine steam nearly the entire stroke; the cam so shaped that when it is brought into operation, the valve is moved in such a way as to cut off at the smallest part of the stroke at which the engine is required to work. These motions are combined by means of a sector operated on by the governor, that when the governor balls fall in consequence of the increased power required from the engine diminishing the speed, the eccentric is brought into operation on the valve; and when the engine is doing little work, the operation of the governor by sliding the sector brings the cam into operation, to cut off, and allow the engine but little steam; the regulation of the position of the sector by the governor thus at any intermediate point or at the extremes, supplying steam and causing the valve to cut off, in proportion to the work to be performed; and by a peculiar apparatus, in case the valve does not supply the required steam to keep up the momentum, the throttle valve is opened farther, or the reverse operation is performed if the work be thrown off the engine so as to need little steam."

Claim.—"I am aware that the cam and eccentric have both been used to work the valves of a steam engine; therefore I do not claim them separately; but I am not aware that they have ever been combined by means of a sector, thereby bringing either the cam or eccentric into operation alone, or together, to give the valve a motion between the two extremes of a full supply and a quick cut-off, as required. And I am also aware that a

screw has been moved from a governor, to regulate the amount of steam or water supplied as active power to the engine; but I am not aware that the governor has ever been used to bring either the cam or eccentric into operation on the valve, by means of the screw or any other suitable device. Therefore, what I claim is, 1st, The combination of a cam and eccentric by means of the sector, or its equivalent, to operate on the valve, or parts that move the same, and cut off or work with the full pressure by the eccentric, according to the position of said sector, as described and shown. 2d, Adjusting the position of the sector by means of the governor, through the screw or other suitable means, whereby the governor regulates the position of the sector, to communicate the desired motion to the valve of the engine from the eccentric or cam, or both, according to the power required from the engine, as specified. 3d, The rod and points, to take motion from the block at its extremes of motion, and communicate the same by means of the right angle lever to the throttle or stop valves, as specified."

36. For an *Improvement in the manufacture of Plain and Figured Fabrics;* Frederick W. Norton, Lasswade, Great Britain.

"My said invention relates to the manufacture or production, under various modifications, of a novel class of plain or figured fabrics, applicable for a variety of purposes, but more especially for such uses as what are technically termed 'furnitures,' or furniture drapery, as usually applied to, as for example, table covers, curtains, tapestries, carpets, and trimmings."

Claim.—"Having now described and particularly ascertained the nature of my invention, and in what manner the same is or may be used or carried into effect, I may observe in conclusion, that I do not confine or restrict myself to the precise details or arrangement which I have had occasion to describe or refer to, as many variations may be made therefrom, without deviating from the principles or main features of my invention; but what I consider to be novel and original, and therefore claim, is, 1st, The manufacture of woven fabrics by cross weaving, by carrying the cross warp alternately over a stationary warp, and binding the cross warp on each side of the stationary warp by a shot of filling. 2d, Carrying contiguous movable cross warps over and across each other's path, and over one or more stationary warps, and binding said cross warps to the stationary warps by shots of filling. 3d, The manufacture of ornamental fabrics, by cross weaving elongated printed warps, as described."

37. For an *Improvement in Hanging Mill Saws;* James Rankin, Detroit, Michigan.

"The nature of my invention consists in providing mill and other saws at one or both ends with a cylinder and piston, said piston being coupled to the end of the saw by its rod; then, by applying atmospheric or other pressure, with any elastic fluid, on the side of the piston nearest the saw, any desired tension may be obtained on the saw, (while it is at perfect liberty to reciprocate following the piston, and vice versa,) thereby obviating the heavy sash or frame, while its qualities are retained, and the speed of the mully saw may be obtained without its weight and thickness, and consequent loss of power and timber."

Claim.—"What I claim is, the arrangement of an air chamber cylinder and valve, in the manner substantially described, for the purpose of straining saws in motion, by the elastic pressure of compressed air, or its equivalent."

38. For an *Improvement in Screw Fastenings for Boots and Shoes;* John Chilcott and Robert Snell, Brooklyn, New York.

"The object of our invention is, to make a screw fastening that will hold the parts together with perfect security, and at the same time allow the inner and outer surfaces of the sole to be made as smooth and even as when other means of security or attachment are used. This screw fastening consists of a double metal screw, or two male screws of different sizes, of which the larger is hollow, and contains a female screw to receive the smaller. These screws are inserted through the sole from opposite sides; the smaller being inserted from the inside, and the larger being screwed in from the outside, the latter screwing into the sole, and screwing on to the male screw, and drawing the parts together like a screw and nut."

Claim.—"What we claim is, the combination as and for the purposes herein described, of the two screws, of which one forms a nut for the other, and will hold it secure until all worn away."

39. For an *Improvement in Lard Lamps;* Leonard A. Stockwell, Batavia, N. Y.

Claim.—"What I claim is, the combination of the reservoir of a lamp for burning lard

or tallow, with an outer covering, so arranged as to form an air chamber surrounding the reservoir, in the manner and for the purposes herein mentioned."

SEPTEMBER 20.

40. For an *Improved Machine for Sawing Sticks for Broom Handles;* Thomas J. Alexander, Westerville, Ohio.

Claim.—"Having described my invention, what I claim is, the method herein described of handling and adjusting the log to its place, and to its various positions, for the several cuts, by means of the radius rods or clamping screws, coupled and operated as specified, and suspended by a swinging frame from above, arranged and operated together, as herein set forth; so that by bearing laterally on the screw lever or handle whilst turning it, the clamping screws are swung laterally, and raised or lowered simultaneously, to approach the log on the table, and convey it with facility to the gauge, and to adjust the log expeditiously, when under operation, to its various sets, laterally and vertically, as shown and described."

41. For an *Improved Planetary Hydraulic Steam Engine;* James Black, Philadelphia, Pennsylvania.

Claim.—"What I claim is, the arrangement of the vessels, pipes, and diaphragms, or their equivalents, upon a shaft, so as to revolve with or upon said shaft, substantially as described, for the purposes set forth."

42. For an *Improvement in Turbines;* Uriah A Boyden, Boston, Massachusetts.

Claim.—"What I claim is, 1st, The leaning or inclining of the leading curves or guides to the plane of the wheel, as described. 2d, The making of the inside of the garniture, or the part of the gate next the disk, or both, of such a curvature or form, that the water at the upper part of the stream or streams, where it leaves the garniture or gate, will have a downward motion, or a direction inclining to the plane of the water wheel, and making the upper sides of the passages for the water through the wheel descending or inclining to the plane of the wheel, from the commencement of the passages next the gate to about half-way from the inner to the outer edge of the upper rim of the wheel, where they are nearly or quite horizontal, or nearly or quite parallel with the plane of the wheel; the inclination of that part of the lower surface of the upper rim of the wheel which is next the gate, being the same or nearly the same as that of the lower surface of the gate next said upper rim, and the change from inclining to horizontal being gradual, as by a curve; or making the upper surface of the disk, next the lower rim of the wheel, to incline up toward this rim, and making the lower sides of the parts of the passages through the wheel, which are next the disk, ascending or inclining to the plane of the wheel, so that the stream or streams will gradually diminish in height at the entrance or entrances into the wheel, so that the water which passes in the upper parts of the stream or streams will converge toward that which passes in the lower parts of the stream or streams, before striking the floats, and continuing this converging into the wheel to about one-half the distance from the inner to the outer edges of the rims of the wheels. 3d, The forming of the lower part of the tube which sustains the disk, and the forming of the top of the disk on that part of it next the tube, and fastening these parts together, as above described. I have, in sundry parts of this description and claim, for brevity, written of the turbine as having its common position, in which case the water descends, to pass between the leading curves, without alluding to its ever having any other position; but I do not limit either division of my claim to the case when it has the common position; but I extend my claim to the cases in which the wheel is vertical or inclined to the horizon, and to the case when the water ascends to pass between the leading curves; nor do I limit either division of my claim exactly to the forms above described, but I extend my claim to all forms which are essentially the same."

43. For an *Improvement in Turbines;* Uriah A. Boyden, Boston, Massachusetts.

Claim.—"What I claim is, 1st, The arrangement of a gate at the entrance of the water into the wheel, with a part or all of the garniture or lining, and other parts of the turbine within, over, and about the gate, such that the gate and a part of the garniture, if any be attached to it, may move freely, while the part of the garniture not attached to the gate, and other parts over and about the gate, remain stationary, and so closely fitted that little or none of the water in the flume can run to the upper part of the gate, excepting by passing under the stationary garniture, and afterward upward, so as to diminish the liability of sediment, dirt, or other substances being carried by the water to the upper part of the

gate, or movable part of the garniture, if any be attached to the gate, so as to obstruct the motion of the gate, or movable part of the garniture, essentially as above described. 2d, The leaning or inclining of the floats or buckets of turbines to the rims of the wheels, so that when the wheel of a turbine is working, with the gate next the wheel partially open, the parts of the floats opposite the aperture formed by such partial opening of the gate, will be forward of those parts next the other rim of the wheel, so that the leaning of the floats will diminish the spreading or deflecting of the streams into the part of the wheel opposite the gate, essentially as above described; though I do not limit my claim to any degree of inclination, but extend it to all degrees of inclinations, which will substantially answer the same purpose, as this effect of inclining the floats depends on the streams only partially filling the wheel. I do not extend my claim to inclining the floats to any such turbine or hydraulic motor as has no gate at or near the water wheel, or other means of varying the width, thickness, or number of streams which enter the wheel. 3d, The arrangement of the diaphragms or partitions in reacting wheels, and in the wheels of turbines, at different distances from the rims of the wheels, in the several spaces between the floats, to facilitate regulating the motions of the wheels, essentially as above described; though I do not limit my claim to any particular arrangement as to the distances of these diaphragms from the rims of the wheels, but extend it to all arrangements which operate substantially as above described. But as the effect of these diaphragms depends on the streams only partially filling the wheels, I do not extend my claim to this arrangement of the diaphragms to such motors as have no gate next or near the water wheels, or other means of varying the width, thickness, or number of streams which enter the wheels. 4th, The combination of the device of making the gate at the entrance for the water into the wheel, to move separately from the garniture, with the leaning guides or leading curves, which direct the water into the wheel, so that when the gate is partially open, the part of the water which passes by or near the surface of the gate, in flowing toward this passage into the wheel, made by such partial opening of the gate, has its motion directed the way the wheel turns, in consequence of the leaning of the said guides. I do not confine my claim exactly to any degree of leaning, but extend it to all degrees of leaning which will essentially answer the same purpose. I do not limit either of these four branches of my claim to such turbines or hydraulic motors as discharge the water at their peripheries, but I extend them to such as have the water enter their wheels at their peripheries."

44. For an *Improvement in Hydraulic Motors;* Uriah A. Boyden, Boston, Mass.

Claim.—"What I claim is, 1st, The arrangement of the gates around and next outside of the peripheries of the water wheels, between the wheels and the guides, or other things which cause the water to move obliquely toward the wheels in the way the wheels turn, when the water first strikes the floats or buckets, essentially as above described. 2d, The device to cause the height of the wheel, or the position of the parts which partially confine the water which presses the wheel upward, to vary as the height of the water or fall varies, so that the width of the aperture which lets the water escape from the place where it presses the wheel upward, varies proportionally to the quantities of water pressed into it; so that the force with which the water presses the wheel upward will be nearly or quite constant, though the height of the fall varies greatly. 3d, The combination of a gate around and near the periphery of a water wheel, between the wheel and the guides, or other things which direct the water the way the wheel turns into the wheel, with the parts of the floats near the gate curved, so that the water will strike their concave sides, as above described; though I do not limit my claim exactly to any curvature of the floats, but extend it to all curvatures which will essentially answer the same purpose; nor do I limit my claim to an annular gate, between the wheel and the things which cause the water to move the way the wheel turns, before it enters the wheel, but I extend it to all things which will substantially answer the purpose of a gate, in varying the height, thickness, width, or number of streams that enter the wheel. 4th, The shape of the spaces between the rims of water wheels, which the floats are fastened to, in which they flare toward the axes of the wheels, as above described; though I do not limit my claim to exactly the flaring above described, but extend it to all flaring which will essentially answer the same purpose. The first, third, and fourth branches of my claim apply only to such hydraulic motors as have guides, or other things which cause the water to move obliquely toward the wheels, in the way in which the wheels turn, and pass into the wheels at their circumferential parts, and after acting on the floats, discharge from the floats inward; I do not extend these divisions of my claim to the class of tub wheels and undershot wheels, in which the water generally flows into the wheels in streams, with spaces between the streams, at which spaces the water does not flow into the wheels. Though I have de-

scribed these water wheels as being horizontal, and the gates as being opened by raising, it is obvious that all these four branches of my claim are quite applicable to wheels in other positions, and to cases in which the gate is opened by lowering; and I do not limit either branch of my claim to cases in which the wheels are horizontal, or to cases in which the gates are opened by raising."

45. For an *Improvement in Razor Straps;* Alfred F. Chatman, City of New York.

Claim.—"I claim the metallic renovator, in combination with the spring barrel, or its equivalent, to operate on the strap, as specified. I also claim the convex end and rest, to elevate the centre of the strap, as described and shown."

46. For an *Improvement in Railroad Car Seats;* Isaac Fay, Cambridge, Mass.

Claim.—"I claim the combination of the groove, and one or more dogs, as applied thereto, and made to operate for the support of the back, and to enable it to be elevated, or its supporting pin raised out of the groove, as described. And in combination with the inclined notches and long slot of each bar, I claim the sliding bolt or slide, as applied thereto, and used substantially in manner and for the purpose as specified. And I claim the convex and concave toothed racks, in combination with the seat and the chair frame, the same being for the purpose of enabling the seat to be set with such inclination, either forwards or backwards, as may be conducive to the ease and comfort of the sitter, whether he be in an upright or recumbent position."

47. For an *Improvement in Toilet Furniture;* David Freed, Huntington, Penna.

Claim.—"Having fully described the nature of my invention, what I claim is, the attaching or combining with a washstand, or any other toilet or chamber furniture, the brackets and bolt, when said bolt is thrown against the brackets by means of a crank or knob, at or near the top of the stand, through the levers or their equivalents, in the manner and for the purpose herein set forth."

48. For an *Improvement in Ploughs;* Samuel Hulbert, Ogdensburg, N. York; patented in Canada, September 20, 1852.

Claim.—"What I claim is, constructing a mould board of a plough, so that a horizontal line, drawn at any height across its working side, shall describe the convex arc of a given circle, and any line drawn across its working side at right angles to the base, shall also describe the convex arc of a circle, substantially as set forth."

49. For an *Improvement in Seed Planters;* Samuel Jenkins, Portsmouth, Penn.

"The nature of my invention and improvement consists in attaching an adjustable cutter to and through the drag bar, and through the point of the shovel."

Claim.—"What I claim is, the peculiar shape and construction of the adjustable cutter; its passing through the drag bar, and fitting in a dovetail in the point of the shovel; all in combination as herein described, for the purpose of allowing the tooth to pass easily over any obstructions, and especially to regulate the depth of furrow."

50. For an *Improvement in Hemp Brakes;* Oliver S. Leavitt, Marcellus, New York.

Claim.—"I do not claim as my invention the beating of flax or hemp straw into grooves, for the purpose of divesting it of the shives or woody portion thereof, or the use of rollers, for moving the material to be broken, as that has been done before; but what I do claim is, the combination of a reciprocating beater, with parallel blades, set at decreasing distances from each other, with a fixed bar, fluted or serrated, to correspond with the blades and spaces of the beater."

51. For an *Improvement in Drawing Frames for Hemp and Flax;* Oliver S. Leavitt, Marcellus, New York.

Claim.—"I make no claim to the use of gill bars, attached to chains or wheels, in drawing flax, hemp, and other fibrous substances, as this has been often done before. But I do claim, 1st, The particular form of gill bar described, in combination with the rocking lever, the dog, and cam or tappet, for the purpose of withdrawing the gill pins from the material, and directing the bar's backward movement, in the manner and for the purpose substantially as set forth. 2d, The device by which the rods are pressed down, for the purpose of making the gill pins penetrate effectually the material to be drawn, being operated by the lever in the manner set forth."

52. For an *Improvement in Metal Drills;* Warren Lyon, City of New York.

Claim.—"I do not claim the weight attached to the arbor, irrespective of the levers and

counterpoise; nor do I claim any of the within named parts separately: but what I claim is, the combination of the weight, levers, and counterpoise, constructed, arranged, and operating in the manner and for the purposes substantially as herein shown and described."

53. For an *Improvement in Oil or Fluid Cans;* James R. Nichols, Haverhill, Mass.

Claim.—"I do not claim as my invention the helical spring and cork valve, as applied to other purposes than that of a decanting vessel, or lamp feeder; but what I do claim is, the application to the same of a spring valve or valves, easily and conveniently opened by the thumb or finger, while replenishing lamps or decanting therefrom, whether said spring and valves be made and arranged in the manner as herein described, or other mode substantially the same, by which similar results shall be produced."

54. For an *Improvement in Seed Planters;* Henry Perrin and William Rudduck, Wilmington, Ohio.

Claim.—"Having described our improvements in seed planters, what we claim as new is, the method of supplying the distributing tube with grain or seed from the hopper, by means of the reciprocating or vibratory valve in the hopper, in combination with the cap, and discharging plate and receiving chamber, constructed, arranged, and operating as described."

55. For an *Improvement in Grain and Grass Harvesters;* Philo Sylla and Augustus Adams, Elgin, Illinois.

Claim.—"What we claim as our invention is, 1st, The weighted levers or their equivalents, substantially as described, which carry the sickle bar and sickle, and allow them to vibrate perpendicularly, and accommodate the sickle to uneven ground in cutting grass, which levers may be made permanent when cutting grain, substantially as described and represented. 2d, The link, or hinged brace, or its equivalent, in combination with the weighted levers, which brace prevents the sickle bar from being traversed longitudinally by the action of the sickle, but allows it to vibrate perpendicularly, and accommodate itself to uneven ground, substantially as described. 3d, The stands of the binders, constructed so as to allow them to stand so much lower than the horizontal platform, that they can bind the gavels into sheaves with greater facility, far less labor, and much faster, than by any of the modes heretofore practised."

56. For an *Improvement in Blow Pipes for enlarging Blasting Cavities;* Ancil Stickney, Norwich, Vermont; ante-dated June 11, 1853.

Claim.—"I do not claim the enlarging a drill hole by the use of heat or a blast of air, thrown upon charcoal or other fuel in a state of combustion; but what I do claim is, my improved process of enlarging the drill hole by means of an air blast and charcoal or other combustible fuel, placed in the hole—the same consisting in the employment of a blast tube, made with lateral projections, and a closed or nearly closed bottom, substantially as described; the same enabling me to attain the enlargement of the hole, with a great saving of labor and time, essentially as set forth."

57. For an *Improvement in Compound Blow Pipes for enlarging Blasting Cavities;* Ancil Stickney, Norwich, Vermont; ante-dated May 10, 1853.

Claim.—"I lay no claim to the use of a blast of air or gas, in connexion with coal or fuel, and for the purpose of supplying such with oxygen; but what I do claim is, the instrument for enlarging the drill hole by the employment of gas, as specified; meaning to claim the combination of the two jet chambers, the perforations or orifices, and supply tubes, as arranged substantially in manner and for commingling the gases, and disseminating the flame therefrom entirely around and against the sides of the drill hole, whereby the enlargement of it into a suitable charge chamber may be speedily effected."

58. For an *Improvement in Steam Generators;* Abel Shawk, Cincinnati, Ohio.

Claim.—"Having fully described the nature of my invention, what I claim therein is, a tubular generator, which has a forced circulation, and which, while it lines the fire-box, and is expanded in its diameter from above the fire-box to its termination, is connected to a steam chamber or receiver, outside of or exterior to it, arranged in the manner described."

59. For an *Improved Saw for Water Wheels;* Oscar Willis, County of McDowell, N. C.

Claim.—"Having fully described the nature of my invention, what I claim is, an ad-

justable apparatus for sawing out the grooves or fillets in water wheels, for the reception of the buckets, composed of a two-edged saw, between clamps, and connected by a screw rod to a sliding bar, when said sliding bar is made adjustable upon a radius arm hung to the centre of the wheel—the whole being combined and operating substantially as described."

60. For an *Improvement in Cotton Stalk Cutters or Pulverizers;* George Gorman, Lamar, Mississippi.

Claim.—"What I claim as my invention is, the construction and arrangement of the machine, consisting of rotary whippers or reels on a bar, supported in a frame, admitting of elevation and depression—said whippers being driven by band wheels on one or both supporting wheels of said machine, in the manner set forth, for the purpose of effectually reducing the stalks of cotton, and thus rendering them useful as a manure, and in a condition to offer no obstruction to the plough, in the after cultivation of the land."

SEPTEMBER 27.

61. For an *Improvement in Looms for Weaving Hair Cloth;* Halvor Halvorson, Hartford, Connecticut.

Claim.—"What I claim is, the combination of the trough or troughs, one or two depressers, one or two sets of pincers, applied to the shuttle, and mechanism for opening and closing the pincers; the whole being applied to one or both ends of the lay and to the shuttle, and made to operate together substantially in the manner and for the purpose of carrying hair or hairs, or like matters, into the shed of warps, as specified. And I also claim the arrangement of each or both troughs with respect to the depresser or depressers thereof, and to the shuttle boxes and the lay, substantially as represented in the drawings, the trough in such arrangement being made to extend from the depresser towards the middle of the lay, substantially as specified."

62. For an *Improved Sash Fastener;* Henry Hochstrasser, Philadelphia, Pa.

"My improved fastening is designed to secure the window more effectually, and is stronger and more durable than those heretofore made."

Claim.—"What I claim is, the self-acting catch, made and operating substantially as described."

63. For an *Improvement in Cooking Ranges;* Nicholas Mason, Roxbury, Massachusetts.

"The nature of my invention consists in the adaptation of two ovens to the range, and in such an arrangement of flues, that either one or both of them may be heated as required."

Claim.—"I am aware that hot air chambers have been applied to ranges, for the purpose of heating meats, dishes, &c.; and also that hot water spaces have been applied to the sides of the grates, instead of at the back: I therefore lay no claim to such devices, although I have introduced a description of them, to facilitate the understanding of my range. But what I do claim is, the employment of two ovens, in combination with the peculiar arrangement of the flues around their top, bottom, back, and sides, by which I am enabled to heat five sides of either one or both of them at a time, as set forth."

64. For an *Improvement in the Manufacture of Sheet Iron;* Henry M'Carty, Pittsburg, Pennsylvania.

"The object of my invention is to impart to sheet iron in its manufacture, the beautiful mottled appearance presented by imported Russia sheet iron. The invention consists in the use of planished or hammer-dressed rollers, between which the sheets of iron are passed, after having been prepared according to the process described in my patent of June 29, 1852. These rollers are arranged similar to those of a common rolling mill, and reduce the iron but slightly; their surfaces, which present the appearance seen in the drawings, giving the sheet passed through them the glossy mottled appearance desired."

Claim.—"I do not claim the use of rollers generally; but what I do claim is, imparting to the surface of sheet iron the peculiar mottled appearance of Russia sheet iron, by passing the sheet between a pair of planished or hammer-dressed rollers, in the manner substantially as herein fully set forth."

65. For an *Improvement in Cooking Stoves;* Jordan L. Mott, City of New York.

Claim.—"1st, I do not claim as my invention, any particular mode of securing the top plate of the bottom flue to the series of flue tubes; this may be done in various ways. But what I do claim as my invention is, connecting the top plate of the bottom flue with the

lower part of the series of flue tubes, so that in taking out the series of flue tubes for cleaning, the said top plate of the flue below shall be removed at the same time, and thereby expose to view the lower flue space, greatly facilitating the operation of cleaning. 2d. I do not claim hanging the grate, irrespective of the combination, as my invention. What I do claim as my invention is, the combination of a swinging grate, as described, with the self-acting weighted latch, connected with the plate below the grate as specified, whereby the contents of the grate can be readily discharged, and the grate readjusted by a slight use of a poker."

66. For an *Improvement in Bathing Tubs;* Jordan L. Mott, City of New York.

Claim.—"I do not limit myself to any particular form for the projection, nor to the forms of the channels therein, as these may be varied at pleasure, although I prefer to make the whole as described; nor do I wish to limit myself to the making of the two channels in one and the same projection, as they may be made each in a separate projection, and located at different parts of the tub; nor, finally, do I wish to limit myself to the use of the two channels in combination, as the use of either one of them will greatly improve the bathing tub. I do not claim broadly as of my invention, the connexion of the hot and cold water pipes of a bath tub, so as to discharge hot and cold water together, as this has before been done by a pipe or pipes coupled with the bottom of a tub, and discharging upwards. Nor do I claim broadly the use of an overflow pipe, for carrying off the water, and preventing the water in the tub from overflowing, as a separate device has before been used for this purpose; but when so used, it was so connected with the waste and supply pipes as to necessitate the use of a valve within the waste pipe, with all its attendant disadvantages. What I do claim as my invention is, the before described mode of combining with a bathing tub either one or both of the channel ways, substantially as described, and making, when constructed, part of the tub, one of which channel ways connects the overflow and the waste or discharge holes with the waste pipe, and the other channel way is adapted to the insertion of the hot and cold water pipes, and discharging the hot and cold water together at or near the bottom of the tub, and in a horizontal or nearly horizontal position, substantially in the manner and for the purpose specified."

67. For *Improvements in making Chains;* Christian Sleppy, Newport, Pa.

"The nature of my invention consists in making chains as aforesaid, by a machine more fully specified hereafter."

Claim.—"What I claim is, the forging and making chains out of a solid bar without the welding process, and which is done instantly, as the bar passes between four rollers, with dies on the edges of the same, moulding the links into form, and which may be done out of iron, brass, or any substance suitable to be used as a chain, from the size of a cable to a watch guard."

68. For *Improvements in Annealing Hollow Iron Ware;* David Stuart, Philadelphia, Pennsylvania.

"The nature of my invention consists in covering the inside of iron hollow ware with a paste made of a composition to exclude the air, and which resists the influence of the heat; when the hollow ware is properly prepared in this manner, it is placed in the oven, and heated to a cherry-red, whereby the chill is taken out of the surface, and rendered so soft that it can be turned bright in a turning lathe, or otherwise, preparatory to tinning."

Claim.—"What I claim as my invention or improvement in annealing hollow ware is, the process herein above substantially as described; the same consisting in coating the articles in the manner set forth, with the same composition that will resist heat and exclude air from the surface, and heating the articles so coated in an oven about the length of time specified."

69. For an *Improvement in Smut Machines;* Robert Waskey, Mill Creek, Virginia.

"My invention consists in inserting between the head of the beating cylinder and the fan chamber, a diaphragm with inclined openings, for the purpose of preventing the grain from being carried off with the smut by the action of the blast during the operation of cleaning."

Claim.—"What I claim is, the construction of the diaphragm, the central part being solid, and that near the periphery made in several oblique valvular passages, to check and throw back the kernels of grain, as represented."

70. For an *Improvement in Smut Machines;* William Zimmerman, Quincey, Illinois.

"The nature of my invention consists of a series of two or more stationary cones, with

one, two, or three, or more revolving cones, placed alternately between the stationary cones; the insides or outsides of part or both sides of part or all the cones may be furnished with roughened surfaces, of such a form or kind as will perform the service required."

Claim.—"What I claim in the above described machine for cleaning and scouring grain, hulling rice, pearling barley, hulling buckwheat, or otherwise operating upon grain, seed, &c., is, a series of two or more stationary cones, with one, two, or three, or more revolving cones, placed and operating alternately between the stationary cones; the insides or outsides of part, or both sides of part or all the cones being furnished with roughened surfaces, of such a form or kind as will perform the service required, substantially as described."

71. For *Improvements in the use of Steam for actuating Engines;* Charles E., John, and Samuel Wethered, Baltimore, Md.; patented in England, May 25, 1853.

Claim.—"What we claim as new is, the combining steam and super-heated or surcharged steam, for actuating engines, when generated, the elasticity increased, and operated as set forth."

72. For an *Improvement in preparing Paraffine Oil;* William Brown, Glasgow, Scotland.

Claim.—"1st, I claim the use of super-heated steam as indicated for the purpose indicated. 2d, I claim the mode of separating and purifying Eupione lubricating oil and paraffine, obtained by previous process."

73. For an *Improved Method of Veneering;* Caleb B. Burnap, Assignor to Lucius F. Robinson, Hartford, Connecticut.

"The object of my invention is to make a more perfect and equal pressure on the surface of veneers, in gluing or cementing them, than can be obtained by any other plan heretofore known to me."

Claim.—"What I claim is, the method of pressing veneers on to the surface to which they are to be glued or cemented, by means of a fluid, hot or cold, acting on an interposed flexible substance, such as an india rubber cloth or its equivalent, which will adapt itself to the surfaces, substantially as described."

74. For an *Improvement in Car Wheels;* Daniel P. Fales, West Poultney, Vermont.

Claim.—"I am aware that car wheels composed of two side plates of different shapes cast in one piece with the hub and rim, in which the rear plate is made to combine the inner end of the hub with the face plate, and with alternate portions of the inner edge of the rim, have been made by Bristol and Jackson; and therefore do not claim to be the inventor of this description of car wheels. But what I do claim is, my improved car wheel, composed of the face plate, which curves first inwards and then outwards, and expands into the rim, and the rear plate, which by the series of curves represented, combines the inner end of the hub with the face plate, and with alternate portions of the inner edge of the rim, substantially as herein set forth."

75. For an *Improvement in Railroad Switches;* James M. Dick, Buffalo, N. York.

"The nature of my invention consists in the construction of the sliding bar, to which the ends of the switch rails are attached, with depending flanches or side plates enclosing the slide and the cross piece upon which it works, for the purpose of affording an effectual and certain protection against gravel, dirt, snow, rain, sleet, ice, and other foreign substances, which might otherwise enter between them, and interfere with the operation of the switch."

Claim.—"I do not claim the levers, springs, bolts, or connecting rods; neither do I claim of itself the employment of a sliding bar connected to the switch. But what I do claim is, the construction of the slide, with the depending flanches or side plates, which enclose the slide and cross piece upon which it works, and afford a certain and effective protection against gravel, dirt, snow, sleet, ice, and other foreign substances, which might otherwise enter between them, and derange the operation of the switch."

76. For an *Improvement in Ships' Blocks;* Charles H. Platt, City of New York.

Claim.—"I do not claim the plates for the purpose of securing the cheeks the proper distance apart, for they have been previously used; but what I claim is, the employment or use of the rods passing through the cheeks, in a direction transversely of their fibre, for the purpose of preventing the splitting of the cheeks; said rods also securing the plates to the cheeks, and forming a staple for the hook, as herein described. I also claim the rods

placed underneath the ends of the shaft, for the purpose of preventing the wearing of the cheeks, and thereby forming durable bearings for the shaft, as set forth in the body of the specification."

77. For an *Improved Centrifugal Draining Machine;* William Richardson, New Orleans, La.

Claim.—"Having described the nature of my improved draining machine, what I claim is, the arrangement in the tub of the induction tube, supply bulb, and annular tube or ring, placed below the water line exterior of the tub, in combination with the ascending tubes, and a second annular tube, having discharges, for the purpose of self-priming, protecting the machine from the resistance of water exterior thereto, and giving steadiness to the ascending column of water discharged by the machine."

78. For an *Improved Clamp for laying Floors;* Stephen E. Parrish, City of New York.

"The nature of my invention consists in making a brace having a forked end, with shoulder pieces attached to the under side thereof, so as to straddle one of the flooring beams, in combination with a screw working at right angles to the brace, and having on it a ratchet wheel and lever and pawls, for working up the screw against the edge of the plank."

Claim.—"What I claim is, the use of the brace having clawed ends, for acting at opposite sides of a beam, in combination with a screw working at right angles to the same, substantially in principle of construction and operation as set forth."

Additional Improvement.

1. For an *Improvement in Winnowers and Threshers;* George F. S. Zimmerman, Charleston, Va.; dated Sept. 13, 1853; patented Feb. 8, 1853.

Claim.—"I claim constructing the suction pipe or tube, of any desired form, with a sliding hinged flap bottom, attaching said pipe or tube to the grain discharge or bagging spout, having a sieve-like or reticulated bottom, and using said attachments in combination, for the purpose of cleaning, and chaffing, or double winnowing grain of all kinds, with a blowing blast of air, and a suction draft or current of wind also in combination, and in one operation, and at the same time, for the purpose specifically as set forth. I do not, however, claim inventing or originating the double cleaning of grain, but simply the peculiar combination above mentioned."

Re-Issue for September, 1853.

1. For an *Improvement in Figure or Fancy Power Looms;* William Crompton, Hartford, Conn., late of Taunton, Mass., Assignor to Merrill A. Furbush and George Crompton, Worcester, Mass., Sept. 13, 1853.

Claim.—"Having fully described my invention and the modes of carrying it into effect, what I claim is, 1st, The jacks with hooks or projections thereon, capable of being taken or passed by the lifter and depresser, as required, in combination with the harness or heddles, for the purpose of opening the sheds. 2d, The combination of the jacks, constructed and arranged substantially as described, with the lifter and depresser as described. 3d, The combination of the pattern chain or cylinder with the jacks, constructed in the manner described. 4th, Arranging and connecting the lifter and depresser, which operate the jacks in such a manner that they shall operate simultaneously to elevate and depress the jacks and warps in forming the shed, substantially as described. 5th, Giving motion to the pattern chain or cylinder, substantially as described. 6th, The combination of the pattern chain or cylinder, with the jacks, lifter and depresser, as described. 7th, So constructing or arranging the lifter and depresser and the hooks or projections on the jacks, with reference to each other, substantially as set forth, as to bring the upper warps all into the same plane, and the lower warps all into another, when the shed is opened. I do not claim broadly the bringing of the warps into said planes. 8th, Connecting the hook jacks to the bottom treadles or levers by inclined wires, or their equivalents, to hold the jacks against the tubes or bars of the pattern cylinder or chain, when not thrown out by the rollers or other projections thereon."

Designs for September, 1853.

1. For a *Stove;* S. W. Gibbs, Albany, New York, Assignor to North, Chase & North, Philadelphia, Pennsylvania, September 6.

Claim.—"I claim the raised shield, the lance border, the scrolls, and the borders, forming an ornamental design for a stove."

2. For a *Cooking Stove;* William P. Gray, Penn Township, Assignor to Abraham and Joseph Cox, Philadelphia, Penn.

Claim.—"I claim the design, configuration, and arrangement of the mouldings, panels, and ornaments on the front, back, and side plates of the stove, called 'The Model Parlor Cook,' as fully set forth."

OCTOBER 4.

1. For an *Improvement in Car Wheels;* Joel Baker, Boston, Massachusetts.

Claim.—"What I claim as my improvement in car wheels is, the connexion and intersection of the convex and rim plates by independent and interlacing branches, substantially in the manner and for the purposes set forth."

2. For an *Improvement in Slat Machines for Window Blinds;* Elihu R. Benson, Warsaw, New York.

Claim.—"What I claim is, 1st, The arrangement for moving the hollow augers back and forth in performing the milling of both ends of the slats at once, combined with the slide, operated substantially in the manner and for the purposes specified. 2d, The manner of feeding the dressing and sticking portions of the machine, by means of the slide, operated substantially as specified. 3d, The method herein described, of sticking the wires by means of hooks and drivers, operated substantially as herein specified."

3. For an *Improvement in Corn Planters;* Gardner A. Bruce, Mechanicsburgh, Ill.

Claim.—"I do not claim the dropping slide, nor any peculiar arrangement thereof, as they are used in many drills, and are constructed and operated substantially as the one herein shown; but what I claim is, the employment or use of the balance beams with the rods attached to them, and operating as described, for the purpose of properly adjusting the seed in the holes of the dropping slide, and also to prevent the clogging of the same, as described."

4. For an *Improvement in Machines for Topping Cotton in the Field;* A. A. Dickson, Griffin, Georgia.

Claim.—"Having described the nature and operation of my invention, what I claim is, the employment of two sets of cutters, and one set being adjustable, and revolving in a horizontal direction, and the other being fixed, and revolving in a vertical direction, and both sets being set in operation through the action of the driving or propelling wheel, in any manner equivalent to that described, and for the purpose specified."

5. For an *Improved Apparatus for Polishing Anvils;* Mark Fisher and John H. Norris, Trenton, New Jersey.

Claim.—"What we claim is, suspending the anvil in the sliding and vibrating frame, and arranging it in respect to the polishing part of the apparatus, and operating them, as fully described."

6. For an *Improvement in Machines for Rubbing and Polishing Leather;* Joseph F. Flanders, Newburyport, Massachusetts.

Claim.—"What I claim is, 1st, The employment of a vertical shaft with arms extending from its sides, for the purpose of carrying the tools and their accompanying mechanism, in combination with a plane surface horizontal table, for the purpose described. 2d, I claim the joint tool holder, either with or without the springs, constructed substantially as described. 3d, I claim the arrangement of a movable table, permitting of an endwise and at the same time downward motion, constructed in the manner described, or the equivalent thereof, for the purpose described. I do not claim to be the inventor of a rotating shaft with arms extending from its sides, carrying tools for the purpose of dressing leather, only when used in a vertical position, and in combination with a plane surface horizontal table; nor do I claim the springs operating to produce the pressure on leather; nor do I claim to be the inventor of the sliding bolts."

7. For an *Improved Machine for Grinding Plough Castings;* Joshua Gibbs, Canton, O.

Claim.—"What I claim is, the carriage upon which the casting is fastened, with the weight and grooved stand, upon which the carriage is moved, arranged, and operated, as described."

8. For an *Improvement in Ploughs;* Robert A. Graham, New Paris, Ohio.

Claim.—"What I claim is, 1st, The screw bolt, or its equivalent, for setting out or in the rear edge of the mould board, with respect to the land side, acting in combination with the bolts, which being tightened, attach to each other the mould board, sheath, and lipped or flanched share, as described, and which bolts being temporarily relaxed, permit the vibration of the mould board about the bolt, without interrupting the continuity of ploughing surface, or disconnecting the several parts. 2d, The shifting or adjusting socket attachment of the beam to the sheath, in combination with the dovetail and adjustable connexion of the rear end of the beam to the helve, or equivalent devices, so as to vary the direction of the draft of the plough to suit the requirement of a change in the flare of the mould board, and other objects, as explained."

9. For an *Improvement in Maize Husking Machines;* Thomas C. Hargreaves, Schenectady, New York.

Claim.—"What I claim is, 1st, The application of the chisel or chisels, and cutter or cutters, in combination with the gate or gates, and operating by gearing, or other means, substantially as described. 2d, I claim the construction of the circular plate, or its equivalent, as described, in combination with the cutters for severing the cob, and the elbow lever for discharging the husks, as set forth. 3d, I claim the combination of cam, lever, and spring, with stud for holding the circular plate stationary whilst removing the ear and husk from the machine, or any other equivalent, as specified."

10. For an *Improvement in Annunciators for Hotels;* Wm. Horsfall, City of N. York.

Claim.—"What I claim is, the manner shown and described, of constructing and arranging the index plates, or in combination with the alarm and its necessary attachments, so that each plate can be operated, and its number exposed to view, and also the alarm sounded instantly after, by simply employing a rod having a tripping arm, in the manner and for the purpose specified. I also claim the manner described and shown, of throwing the index plates back to their proper position by means of the eccentric rod, in combination with the peculiar construction and arrangement of the said index plates, the eccentric being operated in any manner equivalent to that shown and described."

11. For an *Improvement in Straw Cutters;* Richard Ketcham, Seneca Castle, N. York.

Claim.—"What I claim is, the method described, of hanging and operating the cutter by means of its pivoted attachment to the slide, in combination with the guide rod, the latter being made adjustable by the helical spring at the top, or other equivalent device, substantially as and for the purposes set forth. I further claim, in combination with the inclined reciprocating knife, and simultaneously with the descent thereof, giving to the gauge a lateral curvilinear or oblique downward action away from the rear end of the knife towards the front end thereof, and below the cutting edge of the table, substantially as shown and described, whereby the straw is restrained from being crowded towards the back end of the knife by the inclination of the cut, and a free escape is established for the cut particles to pass off, as specified."

12. For an *Improvement in Car Wheels;* Zadock H. Mann, Newport, Kentucky.

Claim.—"I claim the construction, as described, of a cast iron railroad car and locomotive wheel, whose web or portion connecting the hub and rim, consists at the hub of broad radiating plates in the plane of the axis, whence, turning alternately to the right and to the left, they contract in the direction parallel with the axis, and expand proportionally in the direction of revolution; those of each alternate set uniting as they approach their respective margins of the rim concave, so as to form flanches having openings left for each intermediate plate on the other side, forming a braced and counter-braced wheel, possessing the requisite lateral stability and continued support at the rim, together with adequate provision for the strain arising from shrinkage, &c. And this I claim, whether the said web be formed in a cyma reversa curve, as described, or in any way substantially equivalent."

13. For an *Improvement in Smut Machines;* Benjamin Rutter and Henry Rowzer, Piqua, Ohio.

Claim.—"We claim the narrowing of the spout near the grain discharge, in combination with the curved passages, which receive and discharge at their respective apertures the light grain and trash taken from the grain discharge aperture."

14. For an *Improvement in Rotary Steam Engines;* John C. fr. Salomon, Washington, District of Columbia.

Claim.—"What I claim is, the combination of the elliptic wheel and its cylinder, with the sliding abutments or stops, arranged in such manner that a continuous propelling force may be communicated to the wheel without exposing it to unequal pressure of the fluid on opposite sides of its axis, throughout the entire revolution in either direction, substantially as specified. I further claim, in combination with the revolving wheel or piston, the arrangement and operation of the valves described, in such a manner that as the effective propelling area of the piston surface exposed to the impelling fluid between either two abutments diminishes, the wheel is assisted by an increasing area of piston surface exposed to the action of the fluid on the opposite sides of the abutments, as specified; whereby the propelling fluid may be worked expansively without impairing the uniformity of the active power of the engine, as set forth."

15. For an *Improvement in Cooking Ranges;* George S. G. Spence, Boston, Mass.

Claim.—"I claim as my invention the arrangement of the openings and damper, with respect to the arrangement of smoke flues above and below them, substantially as above specified, by which combined arrangement I am enabled, when desirable, by the direct draft, to cause the heat to pass under the back half of the bottom of the oven, up alongside the entire back of the oven, and up the rear portion of the left side of the oven, and over the top of the oven into the chimney, instead of carrying it entirely around the oven, as set forth. I do not claim to so combine a hot air flue with a fire place, and a flue extending directly therefrom to and underneath an oven and up the rear end of such oven, that such hot air flue shall pass only in contact with the back of the fire place and with the oven flue; but what I do claim is, the above described arrangement of the fire-place, boiling chamber, and smoke flues leading under the oven, and in rear of the back thereof, in combination with the peculiar arrangement of the hot air chambers, and whereby the fire place and oven flues are not only made to heat the air flues, but the bottom plate of the boiling chamber is also made to impart heat thereto, and the back as well as the front of the upright air flue is also heated by the smoke flue through which it passes, as specified."

16. For an *Improvement in Burglar Alarms;* Edward Brown, Rindge, New Hampshire, Assignor to Josiah Norcross, M. D., South Reading, Massachusetts.

Claim.—"I do not claim the combination of an alarm clock with a lamp-lighting apparatus, they being so applied that on an alarm being sounded by the clock works, they shall set free the separate machinery by which the lamp and friction match are rotated, the latter being carried against a roughened surface for the purpose of igniting it. In my alarm apparatus, the spring which moves the match holder not only performs the operation of moving such match holder, but it elevates the bell and its spring until the slide is brought up against the shelf, which taking place, the accumulated force on the bell causes the bell to vibrate and sound the alarm. I therefore claim the improvement of so connecting the match holder and the bell spring with the slide, that the spring of the slide on being set free by the opening of the door, shall not only elevate the match holder, but set the bell in motion, so as to cause the alarm to be sounded by it, in manner as specified."

17. For an *Improvement in Machines for Paring Apples;* Ephraim L. Pratt, Worcester, Assignor to James Sargent and Dan. P. Foster, Shelburn, Massachusetts.

"The machine having been constructed and completed as described, an apple is placed upon the fork, and the shaft turned by the crank, the worm turns the gear, with the shaft and gear, which drives the sector gear which carries the shaft and rod, so as to move the knife over the surface of the apple as it is turned by the fork, and pare it completely, except a small space between and around the fork. By the time the apple is completely pared, except the portion above mentioned, the wheel will have turned so that the blank space will be against the sector gear, so as to release it and allow the spring to turn the sector gear back to place the knife in the position it is represented, when the apple pared may be removed, and another put in its place and pared, as above described. I contem-

plate that the construction of my machine may be varied without departing from the principles of my invention."

Claim.—"What I claim in the above described machine for paring apples and other vegetables is, hanging or connecting the block which carries the knife to the rod which carries said block, so that the block and knife can vibrate in one or either direction, (by means substantially such as are herein described, or their equivalents,) so as to allow the knife to vibrate and accommodate itself to any irregularity in the surface of the apple or vegetable pared, substantially as described."

18. For an *Improved Hydraulic Ram;* Joseph C. Strode, East Bradford, Pennsylvania.

Claim.—"What I claim is, the application of the brachystochrone curve to the conduit pipes of hydraulic rams, in the manner and for the purposes set forth."

19. For an *Improved Turbine Water Wheel;* Henry Vandewater, Albany, New York.

Claim.—"What I claim is, the manner or method of regulating the discharge openings of the buckets from the outside, in combination with the central gate, for adapting the wheel to varying heads of water, and to the nature and amount of work to be done by it, consisting of the circular gate, constructed, arranged, and operated with the wheel, substantially as in the manner set forth."

20. For *Improvements in Air Engines;* James A. Woodbury, Winchester, and Joshua Merrill and George Patten, Boston, Massachusetts; patented in England, Jan. 5, 1853.

Claim.—"What we claim is, supplying the air pump from a receiver into which air has been condensed by a hand pump, auxiliary engine, or otherwise, (the hand pump or auxiliary engine being used for the purpose of charging and sustaining a uniform pressure in the receiver from which the air pump is supplied,) when the same is done in combination with a second receiver, into which the air is to be still more compressed and maintained at a uniform pressure, or nearly so, by the application of heat to the air on its passage to the working cylinder, all in the manner and for the purposes above set forth."

21. For an *Improved Stop Cock;* Elizur Wright, Boston, Massachusetts.

Claim.—"I do not claim the application of rubber or soft elastic substances as packing to valves; nor do I claim the ball shaped valve, the ball having been previously used to answer as a valve in peculiar circumstances different from those to which my invention applies; what I claim is, the combination of a ball with an elastic cylindrical ring seat, constructed with or without a wire, as described, for the purpose of forming a valve."

22. For an *Improved Throttle Valve Arrangement;* John E. Anderson, City of N. York.

"The simplest way of constructing the valve seat is to cast the cylinders with a short length of pipe, which will constitute a valve box. The only fitting up required will then be the boring of the cylinders, and the turning of the valve to fit them. The slots may be so narrow that they would close and open to their full width with the smallest desired amount of motion. On account of the small amount of motion that is necessary, the wear of the valves will be very slight. If slots are made on opposite sides of the valves and cylinders, they will be perfectly balanced in all directions, one balancing the other, and the steam acting equally on all sides of each; thus the friction on every part of the wearing surface will be the same, and the movement being the same, the wear will be equal."

Claim.—"What I claim is, the combination, to serve the purpose of a throttle valve or regulator, of two hollow cylindrical valves, connected with a lever on opposite sides of its fulcrum, and having slotted openings, corresponding with similar openings in the cylindrical valve seats; the several openings being arranged in the manner as substantially set forth."

23. For an *Improvement in Magazine Guns;* Edmund H. Graham, Biddeford, Mass.

"The operation of the gun is as follows: by depressing the trigger guard, the charge receiver and magazine are simultaneously rotated, the former far enough for the reception of the charges of powder and ball, or shot, and the latter so as to carry a load of such powder and ball or shot, directly into line with the connecting passages of the barrel. By turning the gun a little, a load will pass from the magazine into the charge receiver. This done, the trigger guard is to be moved up to the stock, and while this takes place, it rotates back the charge receiver so as to close the passages that convey the load through the side of the barrel, and bring the nipple or cone passage into communication with the pow-

der in the charge receiver. On pulling the trigger, a discharge of the gun will take place. This operation may be repeated while there are loads in the magazine."

Claim.—"I do not claim a rotary magazine connected with the barrel of a fire arm, such being in common use in repeating guns; nor do I claim to combine a magazine for powder, balls, and priming, with a hollow cylinder or tube made to encompass and revolve on a barrel, while the barrel is provided with holes or passages to receive the load from the magazine when the latter is turned around on it into a suitable position; nor do I claim the combination of a rotary charge receiver (placed within the barrel or breech of a gun,) and a stationary loading magazine affixed on the barrel or breech; but what I do claim is, the arrangement of the series of ball chambers, &c., and the series of powder chambers, &c., in concentric circles, and on the side of the gun barrel, and out of the sight range, and so as not only to revolve and work against a common plate affixed to the side of the gun, but to operate in conjunction with a rotary charge receiver placed within the barrel, as specified; such arrangement of the magazine of chambers not only causing the powder of the charges to be kept in separate chambers, so as to lessen the danger of accidents, but causing the magazine to be so arranged as to be out of range of sight in taking aim. And I also claim to so combine the percussion hammer or cock, the rotary charge receiver, and the rotary magazine, with the trigger guard, that by the movement of the said guard away from the stock, they may be simultaneously put in motion, and the hammer brought up to full cock, as specified."

24. For an *Improvement in Plough Beams;* Levi B. Griffith, Honeybrook, Penna.

Claim.—"What I claim is, constructing a plough beam of four round iron rods, centre piece, and clamps, in combination as described, the rods being of uniform size from end to end, curved to the shape specified, and welded together at the places designated, the counter piece and rods being held firmly in their position by the clamps, the whole being constructed as described."

25. For an *Improvement in Self-Acting Switches;* Archibald S. Littlefield, Portland, Maine.

Claim.—"I am aware that the relative position of the switch with the main track or turnout, or sliding track, has been changed by the action of a cam or mechanism attached to the car or cars, as well as by devices attached to the locomotive in various ways. I therefore do not claim such, but I base my invention and claim on the above described method of shifting the switch, viz: by the action of the flanches of the wheels on depresser bars, and other mechanism applied to the main and turnout tracks and the switch, substantially as specified. I do not claim depresser bars; but I claim the combination of the transverse rocker lever, the shaft, the toothed sector, and the rock, as applied to the switch and the main and turn-out tracks, and made to operate as specified. And in combination with the toothed sector, I claim the locking plate provided with notches, as specified, the same being for the purpose of locking the switch, in manner as described."

26. For an *Improved Cutter for Boring Wheel Hubs;* Leonard S. Maring, Westport, Massachusetts.

Claim.—"The combining the backer with the shaft and the knife, for the purpose set forth."

27. For an *Improvement in Files and Rasps;* Hiram Powers, now residing in Florence, Italy.

"The nature of my invention consists in forming perforations or throats to the fin, feather, or cutting surfaces of rasps or files, for the purpose of allowing said rasps or files to clear themselves of the material cut away by them, and to prevent their filling or choking, by admitting or allowing the particles to pass through said perforations or throats."

Claim.—"What I claim is, the forming of perforations or throats to the cutting edges of files or rasps, for allowing the particles cut away to pass through, and to prevent the instrument from clogging or choking, substantially as described."

28. For an *Improved Machine for Turning Spiral Mouldings;* Philip P. Ruger, City of New York.

"My invention consists in the combination of rotating tools, the axes of motion of which are perpendicular to the axes of motion of the article to be cut, so as to cut any variety of pattern in the cross section with very bold and complex under cutting, in any style desired."

Claim.—"What I claim is, combining with a rotary progressive motion of the article to

be cut, a series of cutters placed around the article to be cut, of any desired configuration, or varieties of configuration, to form and complete the pattern upon the article; said cutters being made to revolve in a stationary frame perpendicular to the axis of motion of the article to be wrought, either in a radial line, or somewhat inclined thereto, so as to form the desired figure and undercut to any extent desired."

29. For an *Improvement in Gold Washers;* John H. Ward, Sonora, California.

"The nature of my invention consists in the method of arranging the several parts, one over the other, and operating them, so arranged, as to perform the whole washing and separating process, in a compact machine, occupying very little space, easily transported, and at great saving of water."

Claim.—"I do not claim washing or agitating the mass or earthy matter containing the gold, in a tub, box, or cistern; nor do I claim simply washing the earth without a current of water: but what I do claim is, the employment of the reciprocating perforated trough, armed with cutters or breakers, in combination with the sieve and decanting trough, arranged beneath the reciprocating trough; and in combination with said reciprocating trough, I claim the percolating plate, arranged above the same."

30. For an *Improvement in Propellers;* Charles T. P. Ware, City of New York.

"I construct my blades of india rubber, in any of its various forms of preparation, or of any other elastic or pliant material, in combination with elastic ribs, or with inflexible parts."

Claim.—"What I claim is, a propeller having one or more blades, the front and rear edges of which are of unequal stiffness; the blade or blades thus constructed being arranged upon an oscillatory shaft, and operating substantially as set forth."

31. For an *Improved Guide for Doweling Felloes for Wheels;* William C. Dean, Jacksonville, New York.

Claim.—"What I claim is, the combination and arrangement of the tube, guides, and set screw, for the purpose of holding the wood and guiding the bit, as described and set forth."

32. For an *Improved Daguerreotype Plate Holder;* Marshall Finley, Canandaigua, N. Y.

Claim.—"I do not claim holding daguerreotype plates to be buffed by the outward pressure of spiral springs against the turned edges of the plates; but what I do claim is, constructing a solid daguerreotype plate holder or block, having fastenings at each corner made by spiral springs, in combination with tightening bolts, having concave heads, into which the bent or turned corners of the plate to be buffed are hooked, so as to admit of a uniform buffing, as set forth."

33. For an *Improved Machine for Jointing Staves;* Charles B. Hutchinson, Syracuse, New York.

Claim.—"What I claim is, 1st, The use of the circular guide-ways, in combination with the movable piers or bearings, and the cams or levers, or other suitable means of moving the same simultaneously and equally along said circular guide-ways, so that the saws or other cutters may be instantaneously adjusted for any required width of stave, without stopping their motion, or changing their direction towards a constant central point. 2d, The use of the wing or leaf guage, in combination with the index moving over a graduated arc or dial, both moving in connexion with the saws, so as to indicate at a glance the width between the saws, and to guide the operator in setting the stave on its bed plate, and adjusting the saws. 3d, The mode of jointing staves to any required bilge and level, without bending or springing them by rotating them endwise in a plane perpendicular to their width, between saws or other cutters, so inclined as to give the correct level, whether adjustable or not; said rotation being upon a circle, or other proper curve, such as to present each part of the stave to the action of the inclined cutters at the precise point or height requisite to give it its exact proportionate width or bilge; the rotation being obtained by means of a central arch piece moving over rollers about a constant centre of motion, substantially as described, or by other equivalent means."

34. For an *Improvement in Processes for Dechlorinating Bleached Fabrics;* J. Augustus Roth, Philadelphia, Pennsylvania.

Claim.—"What I claim is, the process of removing chlorine from fabrics by means of the solution herein described, and denominated anti-chlorine, or by means of any other solution substantially the same, in the manner and for the purpose as described."

35. For an *Improvement in Looms for Weaving Coach Lace;* James H. Murrill, Richmond, Virginia.

Claim.—"What I claim is, 1st, The revolving pliers, constructed as described, and operated by the spindle, whirl, connecting rod, lever, and cams, in combination with the finger, constructed and operated as specified, wedge, and cylindrical stand, by which combination the needles, upon which the pile is formed, are seized, removed from the finished portion of the fabric, carried up, inserted under the colored warp selected by the jacquard for the figure, and released, substantially as specified. 2d, The construction of the stationary shuttle box, as described, having its front sustained by, and movable about the projecting rod, so as to operate the ungearing apparatus upon a miss-throw of the shuttle, in the manner specified. 3d, The combination of the sliding reed with the stationary shuttle box, when constructed and operating substantially as specified. 4th, The combination of the notched wheel, rock shaft, and arms, with the lever, spring, shaft, rod, and bar, arranged substantially as described, for operating the ungearing apparatus in the manner specified, when a derangement occurs in the machinery operating the needles. 5th, The springs, as arranged upon, in combination with the rods, by means of which the strain upon the eyes of the harness is diminished, substantially as specified."

36. For an *Improvement in Cooking Ranges;* John P. Hayes, Boston, Massachusetts.

Claim.—"What I claim is, 1st, The receiving or box flue, formed under the oven, in the manner above described, and for the purpose specified. 2d, I claim so combining a movable oven sliding upon a stationary bottom through which the hot air is admitted, with the smoke flues about the same, as to cause the smoke, &c., to pass about and over the oven, and the hot air to pass into the same, as described."

37. For an *Improvement in Machines for Punching Metal;* Ozias J. Davie and Thomas W. Stephens, Erie, Pennsylvania.

Claim.—"What we claim is, disconnecting the punch stock from the machine automatically at each operation of the punch, by means of the weighted lever and key, or their equivalents, for the purpose of affording the operator time to place his sheets, without regard to the motions of the machine, when by a slight movement of the ball or lever upon the rising of the punch, the connexion can be again formed, substantially as described."

38. For an *Improvement in Camphine Lamps;* John Newell, Boston, Massachusetts.

Claim.—"What I claim is, 1st, The silvering of the perforated metal, or brass, copper, or iron wire gauze, used in safety lamps and cans, or other vessels, designed to prevent explosions from the vapor of camphine, burning fluid, &c., the silvering being applied for the purpose of preventing the corrosion of the metal or wire gauze, as above described, by the most economical process. 2d, The introduction of perforations, as above described, in the caps of lamps used for burning camphine, burning fluid, &c., so small as not to admit the communication of flame through them, for the purpose of allowing the escape of the vapor formed within the lamp, from camphine, burning fluid, &c., and thereby preventing the bursting of the lamps by the pressure of the vapor. I do not claim the use of any perforations in lamps for burning camphine, burning fluid, &c., except such as are constructed so as to prevent the passage of flame on the principle of Sir Humphrey Davy, relative to the passage of flame through perforated metal."

39. For an *Improved Planing Machine;* Richard H. Pindell, Fayette County, Assignor to Wm. J. Shurman, Washington, Kentucky.

"The nature of my invention consists in planing boards with reciprocating knives, having uniform and continuous feed motion, the planes cutting on their backward as well as forward stroke; possessing, at the same time, a partial reciprocating rotary motion about an axis perpendicular to the surface planed."

Claim.—"What I claim is, 1st, The combination of the differential velocities of feed motion, and the motion of the knives, that is, when their relative speed is such that the knives shall cut on their back as well as on their forward motion, in the manner and for the purposes substantially set forth. 2d, Giving to straight-edged planes for dressing lumber, a partial reciprocating rotary motion about their own centre, for the purposes and in any manner substantially the same as described and shown in the drawings. 3d, I claim a yielding pressure roller, placed in front of the stocks, in combination with an endless planing bed, for the purpose of feeding planks, &c., to the plane, operated in any manner substantially the same as before set forth."

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40. For an *Improvement in Ploughs;* Cornelius R. Brinckerhoff, Batavia, New York.

"The nature of my invention consists in attaching to any common plough, two wheels of different sizes and shapes, the small one to run upon the land, the large one to run in the bottom of the furrow with its side against the land, by a movable iron axle passing through holes in the bottom part of two common cast iron lifters or supporters, which are attached to the beam, one on each side, which have the effect of holding the plough perfectly steady, and regulating both the depth and width of the furrow slice."

Claim.—"What I claim is, 1st, Combining with the plough beam between the plough and the clevis, two wheels, one on each side of the beam, and of different diameters, the one resting in the furrow and the other on the land, for the purposes set forth and described. 2d, I also claim making the tread of the furrow wheel narrow, for the purposes described. 3d, I also claim making the said wheels, especially the furrow wheel, adjustable in the direction of its axis, for the purpose of adapting its position to furrows of different widths. 4th, I also claim making the furrow wheel beveling outward on the side which presses against the land, as above described, and for the purposes herein before set forth. 5th, I also claim making the small wheel adjustable vertically with reference to the shaft and the large wheel, as described."

41. For an *Improvement in Hullers of Grass Seed;* Henry P. Byram, Louisville, Ky.

"The nature of my invention consists in removing the chaff or hulls from the seed by pressing and holding it up against an emery or sand wheel, by an unvarying pressure, whether the hopper be more or less full."

Claim.—"What I claim is, in combination with the rubbing or scouring wheel, the method of feeding up and holding against the said wheel the seed to be cleaned, by a pressure which is unvarying, whether the hopper be full or not, substantially as described."

42. For a *Detachable Lining for the Fire Boxes of Steam Boilers;* John B. Collan, Reading, Pennsylvania.

Claim.—"What I claim is, a detachable lining for the sides and ends of fire boxes of steam boilers, consisting of one or more tubes connected with the adjacent water space by means of hollow bolts, or their equivalent, substantially as herein set forth, so as to admit of the ready removal and replacement of the tubes."

43. For an *Improvement in Ash Pans for Locomotive Engines;* Gilman Davis, Roxbury, Massachusetts.

Claim.—"What I claim is, the taking in of the air in front of the ash pan, and introducing it into the fire box in a direction opposite to the furnace doors, to protect the fireman from the back-lash of the fire when said doors are opened, by means substantially such as described."

44. For an *Apparatus for opening and closing Gates;* Samuel G. Dugdale, Richmond, Indiana.

"The nature of said improvement consists in hanging the gate in such a manner, that by moving the bottom of the gate in an oblique direction from and to the post, I cause the gate to open, close, and fasten, by its own weight, and assume a perfectly plumb and level position, both when open and closed, and always opening from the horses, allowing the vehicle to pass through without stopping. It consists, further, in the arrangement of levers in such a manner, that by the vehicle passing over the vertical lever, causes the gate to open, and at the same time changes the opposite lever, so that the vehicle, on passing over it, closes the gate, and draws the levers to their original position. The gate arranged upon this plan may be opened and closed the same as any other swinging gate now in use, without operating the machinery."

Claim.—"What I claim is, 1st, Opening, closing, fastening, and unfastening the gate, by moving the bottom of the gate in an oblique direction from and to the post upon which it is hung, as specified. 2d, The use of the pendulous and vertical levers and arms, in combination with the hinges of the gate, the whole being operated and arranged in the manner and for the purpose as set forth."

45. For an *Improvement in covering Iron with Gutta Percha;* Charles Goodyear, New Haven, Conn.

Claim.—"What I claim is, the art or method of coating articles composed wholly or

partly of metal, with compounds of caoutchouc or gutta percha, and subjecting the same to a high degree of artificial heat, or the process of vulcanization, substantially as specified."

46. For an *Improvement in Hill-side Ploughs;* Nathan Harrison and John W. H. Metcalf, Ridgeville, Va.

"The nature of our improvement or invention consists in its superior strength, durability, and simplicity, being less complicated, and not so liable to get out of order as other hill-side ploughs, and the construction being so simple that any country smith can make it, the entire plough being of wrought iron, except the mould board, which is cast."

Claim.—"We claim curving downward and inward the beam in the rear part, so as to cause it to support the rotary part of the plough, which it performs in combination with the standard, in the manner and for the purposes set forth."

47. For an *Improvement in Driving Circular Saws;* Joseph Harris, Jr., Boston, Mass.

"The nature of my invention consists in hanging the arbor, with a pulley and saw thereon, in a frame, the axis of the arbor frame being parallel to the axis of the large driving pulley, and within its circumference, with springs attached to the said frame, the tendency of which is to swing the arbor frame in such a manner as to bring the surfaces of the pulleys together, and a few pounds applied by the springs will cause many pounds pressure on the surfaces of the pulleys."

Claim.—"I do not claim driving pulleys by their surfaces coming in contact with each other, that method having before been used; but what I claim is, 1st, The method of hanging the arbor frame on journals for its axis, each side of the driving pulley bringing the axes of the arbor frame within the circumference of the driving pulley, or on a line passing through the driving pulley, in such a manner and at such an angle with a tangent to the driving pulley, that the act of feeding the stuff to the saw or cutter will press the arbor pulley against the driving pulley, in the manner and for the purpose described. 2d, I claim hanging the arbor frame on such an angle, that the act of feeding the stuff to the cutter will press the arbor pulley against the driving pulley, in combination with a spiral spring, or its equivalent, for holding the arbor pulley firmly against the driving pulley, as described."

48. For an *Improvement in the attachment of a Harrow to a Land Roller;* Daniel Hill, Bartonia, Indiana.

Claim.—"What I claim is, the arrangement and mode of attaching the harrow to the forward axle of a roller, in the manner and for the purpose set forth."

49. For an *Improvement in Cob and Stalk Cutters;* Thomas B. Jones, Carloville, Ala.

Claim.—"What I claim is, the combination of the feeding trough, its gauge disk, the tube, and its gauge ring, with the knives, whereby the same knife will at the same time cut fodder coarse and cobs fine, and thereby improve the quality of the product as feed for animals."

50. For an *Improvement in Winnowers of Grain;* Henry M. Keller, Newark, Ohio.

Claim.—"What I claim is, the trap door, in combination with the screen, arranged and operated in the manner and for the purpose set forth."

51. For an *Improvement in Straw Cutters;* J. J. Parker, Marietta, Ohio.

Claim.—"What I claim is, operating both the reciprocating gate and the feeding rake, by means of the compound spring pitman, substantially as set forth."

52. For an *Improvement in Rotary Root Digging Cultivators;* Samuel Snow, Fayetteville, and Alexander Hine, La Fayette, New York.

Claim.—"What we claim is, the combination of the two toothed cylinders with the receiving box, all being arranged and suspended on an adjustable frame, in the manner and for the purpose set forth."

53. For an *Improvement in Shaking Shoes of Winnowers;* Jacob L. Van Valkenburgh, Ogdensburgh, New York.

Claim.—"What I claim is, not the use of sieves in cleaning grain, but the communication of a reciprocating rotating motion to the sieves or separators, and also the construction of the machine, in the manner substantially as above set forth, for separating grain from cockle and other impurities."

54. For an *Improvement in Treating Metals while in the Molten State;* Horace W. Woodruff, Watertown, New York.

Claim.—"What I claim is, treating metals while in the molten state to expel impurities therefrom, by immersing therein some porous or cellular non-conducting substance or substances containing liquid matter, substantially as specified."

55. For an *Improvement in Vegetable Cutters;* D. Henshaw Whittemore, Chicopee Falls, Massachusetts.

Claim.—"What I claim is, the combination of the long and short knives on the periphery of the cylinder with the hopper, arranged as described."

56. For an *Improvement in Washing Machines;* H. G. Robertson, Greenville, Tenn.

"The nature of my invention consists in constructing the machine with a rocking frame having a hinged slatted washing board, arranged inclining, in each of its ends, and having suitable cords for holding the clothes while being washed, arranged under its bottom, in combination with the box or tub, in the sides of which the bearings of the rock shaft are secured and allowed to turn. The said tub being divided into two compartments, so that white and brown clothes may be washed separately in the same machine and at the same time; and the bottom of the tub being slatted so as to work in combination with the slatted wash boards, and effectually operate upon the clothes in each compartment alternately, and remove all dirt from them with the greatest ease and despatch; the rocking of the shaft and the consequent up and down motions of the slatted wash boards being the only operation requisite, and this can be done by a child. The said alternate motions of the rocking frame causing either of the slatted washing boards having the clothes tied under them, to descend and strike parallelly the horizontal bottom and the hot suds, which latter are forced through the pores of the clothes by the two slatted surfaces coming together, and thereby caused to separate the dirt from them, the air which the clothes catches in descending aiding materially the entrance of the steam or suds through the pores of the clothes, and the effectual operation of the same."

Claim.—"What I claim is, the employment of the double chambered slatted bottom tub, in combination with the vibrating or rocking frame, constructed with two hinged slatted wash boards, which have cords passing under the bottom of them for holding the clothes against their bottoms while washing. The said boards being made movable or swinging, so that the clothes can be easily laid on the cords, and they also being set in such a position that they and the clothes will always be caused to strike parallelly the slatted bottom and the hot suds in the tub, and force the latter through the pores of the clothes, and cause them to be washed clean; the whole being constructed and arranged and operated in the manner described."

57. For *Improvements in Griddles;* Banford Gilbert, Pittsburgh, Pennsylvania.

Claim.—"What I claim is, the constructing of griddles of two pieces, separated by flanches, furnished with openings to admit of the passage of cool air between the upper and lower pieces of the griddle, which openings may be closed at pleasure, substantially as described."

58. For *Improvements in Oscillating Engines;* Alexander B. Latta, Cincinnati, Ohio.

"The nature of this invention and improvement consists in so arranging the valve chambers, outside of barring or trunnion; by this arrangement the eccentric rod is allowed to pass across the centre of the trunnion, thereby communicating with the slide bar, to which the valves are attached, and thereby giving independent motion to the valves, regardless of the oscillating of the cylinder. The steam pipe is so formed as not to interfere with the eccentric rod; the sliding bar has a curved slot where the wrist pin is attached, which may be used to shorten the throw of valves, but it is not an essential appendage; the steam enters the pipe, and then enters the chest, thence to cylinder, does its work, and then into the passage which leads to the trunnion, thence around the cylinder and out of the trunnion. The mode of operating this engine is the same as any other engine; the adjustments are to be set in the same way as a stationary cylinder; the setting of the valves in every way the same."

Claim.—"What I claim is, the mode of arranging the valve chambers outside of the barring or trunnion on which the cylinder oscillates, in such manner as to allow the wrist pin of the eccentric rod to move equally across the centre of the trunnion, and moving equally above and below, and thereby giving motion to the valve or valves, by said eccentric, independently of the oscillating of the cylinder. I also claim the sliding bar or bars

to which the eccentric is attached, and passing up the whole length of the valve chambers to the end or ends, as the case may be, and attached to the valve rods, thereby giving motion to the valves. I claim this arrangement, as set forth by drawings, or their mechanical equivalents."

59. For an *Improvement in Life Boats;* Yelland Foreman, City of New York.

Claim.—"What I claim is, constructing the body of my life boat wholly of metallic tubes, brazed, or similarly united throughout, thus affording a water tight and solid metallic connexion, and mutual bracing of every part, as shown, whereby are attained the objects explained, in a compact and generally advantageous manner. I further claim, in combination with such boat, the detachable tubular seat, as described."

60. For an *Improved Valve Motion of Oscillating Engines;* William Stephens, Pittston, Pennsylvania.

Claim.—"What I claim is, 1st, The combined arrangement of the slide valve and guide, which assists the oscillation of the engine in producing, and directs the motion of the said valve, substantially as described, to wit: the valve being arranged to work transversely to the cylinder, and the guide being in the form of part of a helix or screw, concentric to the axis of the cylinder's oscillation, and receiving an arm or cross-head attached directly to the rod or stem of the valve, whereby the intermediate mechanism usually employed is dispensed with. 2d, Giving the valve the necessary or desired lead, by means of the adjustable sliding lining pieces which line the sides of the guide, and are furnished with projecting or rising parts, which will give the necessary lead in working the engine in either direction, as set forth."

61. For a *Machine for Cutting Binders' Boards;* John A. Elder, Westbrook, Assignor to John E. Coffin, Portland, Maine.

Claim.—"What I claim is, 1st, The arrangement of machinery for cutting pasteboard into strips, and those strips a given length, at the same time. 2d, The arrangement of the rocker shaft, rolls, and shears, for the purpose above described. 3d, I also claim the series of shears, or its equivalent, for the purpose described."

62. For an *Improvement in Cultivating Ploughs;* L. M. Whitman, Assignor to Samuel G. Wise, Weedsport, New York.

Claim.—"What I claim is, the employment of the long inclined spring wings, secured at their front ends to the share and main standard, and turning upon the pin, in combination with the mechanical contrivance shown and described, for expanding and contracting the wings, or setting them more perpendicular and nearer together, for the purpose of throwing more pulverized soil against or up to the hills, or setting them less inclined to the horizontal plane, and further apart, for the purpose of allowing the pulverized soil, weeds, &c., to pass over them into the broad open spaces in the centre; the said wings in either case cutting up the weeds and pulverizing the soil, the same as fully set forth."

MECHANICS, PHYSICS, AND CHEMISTRY.

Experimental Investigation of Table-Moving. By M. FARADAY.*

The object which I had in view in this inquiry was not to satisfy myself, for my conclusion had been formed already on the evidence of those who had turned tables,—but that I might be enabled to give a strong opinion founded on facts, to the many who applied to me for it. Yet, the proof which I sought for, and the method followed in the inquiry, were precisely of the same nature as those which I should adopt in any other physical investigation. The parties with whom I have worked were very honorable, very clear in their intentions, successful table movers, very desirous of succeeding in establishing the existence of a peculiar power, thoroughly candid, and very effectual. It is with me a clear point that the

* From the London Athenæum, July, 1853.

table moves when the parties, though they strongly wish it, do not intend, and do not believe that they move it by ordinary mechanical power. They say, the table draws their hands; that it moves first, and they have to follow it,—that sometimes it even moves from under their hands. With some the table will move to the right or left according as they wish or will it,—with others the direction of the first motion is uncertain:—but all agree that the table moves the hands, and not the hands the table. Though I believe the parties do not intend to move the table, but obtain the result by a *quasi* involuntary action,—still I had no doubt of the influence of expectation upon their minds, and through that upon the success or failure of their efforts. The first point, therefore, was, to remove all objections due to expectation, having relation to the substances which I might desire to use:—so, plates of the most different bodies, electrically speaking,—namely, sand-paper, millboard, glue, glass, moist clay, tinfoil, cardboard, gutta percha, vulcanized rubber, wood, &c.,—were made into a bundle and placed on a table under the hands of a turner. The table turned. Other bundles of other plates were submitted to different persons at other times,—and the tables turned. Henceforth, therefore, these substances may be used in the construction of apparatus. Neither during their use nor at other times could the slightest trace of electrical or magnetic effects be obtained. At the same trials it was readily ascertained that one person could produce the effect; and that the motion was not necessarily circular, but might be in a straight line. No form of experiment or mode of observation that I could devise gave me the slightest indication of any peculiar natural force. No attractions, or repulsions, or signs of tangential power, appeared,—nor any thing which could be referred to other than the mere mechanical pressure exerted inadvertently by the turner. I therefore proceeded to analyze this pressure, or that part of it exerted in the horizontal direction:—doing so, in the first instance, unawares to the party. A soft cement, consisting of wax and turpentine, or wax and pomatum, was prepared. Four or five pieces of smooth slippery cardboard were attached one over the other by little pellets of the cement, and the lower of these to a piece of sand-paper resting on the table; the edges of these sheets overlapped slightly, and on the under surface a pencil line was drawn over the laps so as to indicate position. The upper cardboard was larger than the rest, so as to cover the whole from sight. Then, the table turner placed the hands upon the upper card,—and we waited for the result. Now, the cement was strong enough to offer considerable resistance to mechanical motion, and also to retain the cards in any new position which they might acquire,—and yet weak enough to give way slowly to a continued force. When at last the tables, cards, and hands all moved to the left together, and so a true result was obtained, I took up the pack. On examination, it was easy to see by the displacement of the parts of the line, that the hand had moved further than the table, and that the latter had lagged behind; that the hand, in fact, had pushed the upper card to the left, and that the under cards and the table had followed and been dragged by it. In other similar cases when the table had not moved, still the upper card was found to have moved, showing that the hand had carried it in the expected direction. It was evident, therefore, that the table had not drawn the hand and person

round, nor had it moved simultaneously with the hand. The hand had left all things under it behind, and the table evidently tended continually to keep the hand back.

The next step was, to arrange an index, which should show whether the table moved first, or the hand moved before the table, or both moved or remained at rest together. At first this was done by placing an upright pin fixed on a leaden foot upon the table, and using that as the fulcrum of a light lever. The latter was made of a slip of foolscap paper, and the short arm, about ¼ of an inch in length, was attached to a pin proceeding from the edge of a slipping card placed on the table, and prepared to receive the hands of the table turner. The other arm, of 11½ inches long, served for the index of motion. A coin laid on the table marked the normal position of the card and index. At first the slipping card was attached to the table by the soft cement, and the index was either screened from the turner, or the latter looked away: then, before the table moved, the index showed that the hand was giving a resultant pressure in the expected direction. The effect was never carried far enough to move the table, for the motion of the index corrected the judgment of the experimenter, who became aware that, inadvertently, a side force had been exerted. The card was now set free from the table, *i. e.*, the cement now removed. This, of course, could not interfere with any of the results expected by the table turner,—for both the bundle of plates spoken of and single cards had been freely moved on the table before; but now that the index was there, witnessing to the eye, and through it to the mind, of the table turner, not the slightest tendency to motion either of the card or of the table occurred. Indeed, whether the card was left free or attached to the table, all motion or tendency to motion was gone. In one particular case there was relative motion between the table and the hands: I believe that the hands moved in one direction; the table turner was persuaded that the table moved from under the hand in the other direction:—a gauge, standing upon the floor, and pointing to the table, was therefore set up on that and some future occasions,—and then, neither motion of the hand nor of the table occurred.

A more perfect level apparatus was then constructed in the following manner:—Two thin boards, 9½ inches by 7 inches, were provided; a board, 9 by 5 inches, was glued to the middle of the underside of one of these, (to be called the table-board,) so as to raise the edges free from the table; being placed on the table, near and parallel to its side, an upright pin was fixed close to the further edge of the board, at the middle, to serve as the fulcrum for the indicating lever. Then, four glass rods, 7 inches long and ¼ in diameter, were placed as rollers on different parts of this table-board, and the upper board placed on them; the rods permitted any required amount of pressure on the boards, with a free motion of the upper on the lower to the right and left. At the part corresponding to the pin in the lower board, a piece was cut out of the upper board, and a pin attached there, which, being bent downwards, entered the hole in the end of the short arm of the index lever: this part of the lever was of cardboard; the indicating prolongation was a straight hay-stalk 15 inches long. In order to restrain the motion of the upper board on the lower, two vulcanized rubber rings were passed round both, at the parts

not resting on the table: these, whilst they tied the boards together, acted also as springs,—and whilst they allowed the first feeblest tendency to motion to be seen by the index, exerted before the upper board had moved a quarter of an inch sufficient power in pulling the upper board back from either side, to resist a long lateral action of the hand. All being thus arranged, except that the lever was away,—the two boards were tied together with string, running parallel to the vulcanized rubber springs, so as to be immovable in relation to each other. They were then placed on the table, and a table turner sat down to them:—the table very shortly moved in due order, showing that the apparatus offered no impediment to the action. A like apparatus, with metal rollers, produced the same result under the hands of another person. The index was now put into its place and the string loosened, so that the springs should come into play. It was soon seen, with the party that could will the motion in either direction, (from whom the index was purposely hidden,) that the hands were gradually creeping up in the direction before agreed upon, though the party certainly thought they were pressing downwards only. When shown that it was so, they were truly surprised; but when they lifted up their hands, and immediately saw the index return to its normal position, they were convinced. When they looked at the index, and could see for themselves whether they were pressing truly downwards, or obliquely so as to produce a resultant in the right or left handed direction, then such an effect never took place. Several tried, for a long while together, and with the best will in the world; but no motion, right or left, of the table, or hand, or anything else, occurred.—[A passage from the letter in the *Times* is worth reproducing here,—as illustrating in other words the value of this method of self-conviction.—"The result," says Prof. Faraday, "was, that when the parties saw the index it remained very steady; when it was hidden from them, or they looked away from it, it wavered about, though they believed that they always pressed directly downwards; and, when the table did not move, there was still a resultant of hand force in the direction in which it was wished the table should move, which, however, was exercised quite unwittingly by the party operating. This resultant it is which, in the course of the waiting time, while the fingers and hands become stiff, numb, and insensible by continued pressure, grows up to an amount sufficient to move the table or the substances pressed upon. But the most valuable effect of this test-apparatus (which was afterwards made more perfect and independent of the table) is the corrective power it possesses over the mind of the table turner. As soon as the index is placed before the most earnest, and they perceive—as in my presence they have always done—that it tells truly whether they are pressing downwards only or obliquely, then all effects of table turning cease, even though the parties persevere, earnestly desiring motion, till they become weary and worn out. No prompting or checking of the hands is needed—*the power is gone;* and this only because the parties are made conscious of what they are really doing mechanically, and so are unable unwittingly to deceive themselves. I know that some may say that it is the cardboard next the fingers which moves first, and that *it* both drags the table and also the table turner with it. All I have to reply is, that the cardboard may in practice be reduced to a thin sheet

of paper weighing only a few grains, or to a piece of goldbeaters' skin, or even the end of the lever, and (in principle) to the very cuticle of the fingers itself. Then the results that follow are too absurd to be admitted: the table becomes an incumbrance, and a person holding out the fingers in the air, either naked or tipped with goldbeaters' skin or cardboard, ought to be drawn about the room, &c.; but I refrain from considering imaginary yet consequent results which have nothing philosophical or real in them."]

Another form of index was applied thus :—a circular hole was cut in the middle of the upper board, and a piece of cartridge paper pasted under it on the lower surface of the board; a thin slice of cork was fixed on the upper surface of the lower board corresponding to the cartridge paper; the interval between them might be a quarter of an inch or less. A needle was fixed into the end of one of the index hay-stalks, and when all was in place the needle point was passed through the cartridge paper and pressed slightly into the cork beneath, so as to stand upright: then any motion of the hand or hand-board was instantly rendered evident by the deflexion of the perpendicular hay-stalk to the right or left.

I think the apparatus I have described may be useful to many who really wish to know the truth of nature, and would prefer that truth to a mistaken conclusion: desired, perhaps, only because it seems to be new or strange. Persons do not know how difficult it is to press directly downward, or in any given direction against a fixed obstacle: or even to *know only* whether they are doing so or not; unless they have some indicator, which, by visible motion or otherwise, shall instruct them: and this is more especially the case when the muscles of the fingers and hand have been cramped and rendered either tingling, or insensible, or cold, by long continued pressure. If a finger be pressed constantly into the corner of a window frame for ten minutes or more, and then, continuing the pressure, the mind be directed to judge whether the force at a given moment is all horizontal, or all downward, or how much is in one direction and how much in the other, it will find great difficulty in deciding; and will at last become altogether uncertain: at least such is my case. I know that a similar result occurs with others; for I have had two boards arranged, separated, not by rollers, but by plugs of vulcanized rubber, and with the vertical index: when a person with his hands on the upper board is requested to press only downwards, and the index is hidden from his sight, it moves to the right, to the left, to him and from him, and in all horizontal directions; so utterly unable is he strictly to fulfil his intention without a visible and correcting indicator. Now, such is the use of the instrument with the horizontal index and rollers: the mind is instructed, and the involuntary or *quasi* involuntary motion is checked in the commencement, and therefore never rises up to the degree needful to move the table, or even permanently the index itself. No one can suppose that looking at the index can in any way interfere with the transfer of electricity or any other power from the hand to the board under it or to the table. If the board tends to move, it may do so, the index does not confine it; and if the table tends to move, there is no reason why it should not. If both were influenced by any power to move together, they may do so,—as

they did indeed when the apparatus was tied, and the mind and muscles left unwatched and unchecked.

I must bring this long description to a close. I am a little ashamed of it, for I think, in the present age, and in this part of the world, it ought not to have been required. Nevertheless, I hope it may be useful. There are many whom I do not expect to convince; but I may be allowed to say that I cannot undertake to answer such objections as may be made. I state my own convictions as an experimental philosopher, and find it no more necessary to enter into controversy on this point than on any other in science, as the nature of matter, or inertia, or the magnetization of light, on which I may differ from others. The world will decide sooner or later in all such cases, and I have no doubt very soon and correctly in the present instance. Those who may wish to see the particular construction of the test apparatus which I have employed, may have the opportunity at Mr. Newman's, 122, Regent Street. Further I may say, I have sought earnestly for cases of lifting by attraction, and indications of attraction in any form, but have gained no traces of effects. Finally, I beg to direct attention to the discourse delivered by Dr. Carpenter at the Royal Institution on the 12th of March, 1852, entitled 'On the influence of Suggestion in modifying and directing Muscular Movement, independently of Volition':—which, especially in the latter part, should be considered in reference to table moving by all who are interested in the subject.

Royal Institution, June 27.

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*Art-Manufacture.**

(Continued from page 278.)

The study of the productions of a past age and of the beautiful forms of nature has certainly done much for Art of late,—and has laid the foundation from which much more will arise; but the servile imitation which has been unfortunately far more prevalent has filled our shops and houses with productions which call up a smile on the face of the man of taste, whether Englishman or foreigner. In one place we find a row of sphinxes supported by something between an obelisk and a milestone, guarding the entrances of a row of houses in the simplest modern English style. In another we are condemned to clean our shoes upon a scraper composed of two anomalous looking figures, whose wings clasp each other and supply the edge by means of which the mud is to be removed from the sole. On one table we see octagonal jugs which look as though they had been made out of a number of spare pieces, and call up the idea rather of carpentry than of pottery;—on another—probably devised to hold that very unromantic liquid with which we temper the crudity of our tea and coffee—the chivalric temperament of the designer comes forth in great force; around the top edge is an elegant Gothic fret-work, which might have been borrowed from the screen of one of our most beautiful cathedrals. Below, the same ornament is reproduced in an inverted position. Between these two specimens of happy adaptation we find a knight armed *cap-à-pie*,

* From the London Athenæum, May, 1853.

mounted on a fiery charger, galloping at full speed round the sharply curved side of the earthenware, his horse's hoofs being very appropriately placed in close connexion with the sharp points of the lower ornament referred to, and upon which he seems to be galloping. The knight points his lance in the direction of his horse's nose, and the weapon being of considerable length, reaches about one-third round the circumference of the jug. The full effect of the design is not apparent until we glance at the other side of this specimen of Art-manufacture, when we find that another mounted knight is galloping along the top of the corresponding spikes,—and that his lance, describing nearly another third of the circumference, is pointed curvilinearly at the other gentleman on horseback —whom he will certainly not catch sight of until he shall have run him through the body, or been run through by him. We have a brazen Rachel drawing not water, but *ink*, if anything, from an elegant well, shaded by a palm tree in the same hard metal. A young Swiss maiden carries an elegant milk-pail on her head, not intended to hold milk, but a taper. We have Paul and Virginia under a palm tree, which supports a glass for flowers amongst its branches. Apollo dancing and at the same time supporting a glass epergne twice his own size, suggests the not very elegant idea of a drunken porter staggering from Covent Garden with a large basket of flowers. We have candles stuck into elegant cast tulips or China-asters,—gas rushing forth from the head of Minerva,—lamp-stands formed of leaves and flowers, which rest upside down with their tips upon the table, and thus support the superincumbent weight, after the fashion of the clown who stands upon his hands and supports his fellow acrobat with his feet in the air. Such are some of the results that flow from the imitative system, by which the ornaments of a past age are imported and crudely mixed up with objects wherewith they do not harmonize:—or of that system in which the graceful forms of Nature, instead of being *adapted* as ornaments to objects of utility, are applied without taste or judgment, and often degraded to unseemly purposes.

These solecisms are, it is true, to be found in the productions of other countries besides this; but we must admit, that England commits a great many more than her due share of them. It would be very extraordinary if it were not so, considering the very small amount of attention which we have bestowed on Art-education. Dr. Waagen, whose position as Director of the Museum of Fine Arts in his own country, gives weight to his words, says:—"From the first introduction of the Fine Arts in this country to the present day, they have received little or no notice from the Government as such: their encouragement, like that of many other important objects, has been left to the public. The foundation of the Royal Academy itself is of comparatively recent date, and it is self supported. The collection of sculpture and antiquities in the British Museum, and that of painting at the National Gallery, have been formed only within the last half-century, and many of their most valuable treasures are donations of bequests of private individuals. Before the building of the new Houses of Parliament, the distinguished artists of this country had rarely been employed by the Government on works of a monumental character, and such commissions were, from their nature, not the objects of private munificence. This is one principal cause why in the English

school of painting and sculpture, no true monumental style has been as yet formed. Again, it was only in the year 1836, that the Schools of Design were formed; institutions by means of which the Fine Arts have exerted a most beneficial influence on the vast productive energy of Great Britain. Much improvement in every branch of industry has been accomplished by means of these schools, but it must be acknowledged that in many kinds of manufacture the English productions, both in regard to their form and their color, show far less taste than those of other nations. Both the Government and the nation, however, are now becoming conscious of the great importance of Art, not only in its monumental character, but in its relation to industry. The vast range of comparison which the Exhibition has afforded, by the juxtaposition of the products of so many nations, has directed the English mind to more enlightened views; and, from the energy of the national character and institutions, these newly awakened ideas may ultimately prove of the greatest benefit in regard to both the Fine Arts and the manufactures of the country."

Of his own country the Doctor says:—"Since the year 1815 great efforts have been made by the successive monarchs and administrations of Prussia to encourage the Fine Arts in that country. Museums and other buildings of a similar character have been erected; sculptors, and more recently painters, have been employed in the execution of monumental works, and the cultivation of all those manufactures on which Art can exercise any influence has been greatly promoted by the foundation of the 'Institution for Trades' (*Gewerbe Institut*). . . . That these efforts have led to the happiest results, has been proved by the Exhibition which has furnished to Prussia a long-desired opportunity of showing what progress has there been made."

Of France, he says:—"The French have been distinguished for many generations by the great encouragement that they have bestowed, as a nation, on the Fine Arts. The French Government under every change in its outward form has not failed to regard Art as one of the most important instruments of civilization; and recognising its great and beneficial influence on the manufactures of the country, has, by the most liberal grants, placed it in a peculiar manner under the protection of the State. Millions of the national revenue have, in consequence, been devoted to the erection of great public edifices, and to the purchase of the best works of native artists. . . . . In consequence of this encouragement on the part of the Government, the French School of Art has been most fertile in its productions; many branches of Art have been brought to a rare degree of perfection, and the diffusion of an improved taste has exercised a most beneficial influence on a variety of trades and handicrafts. By these means Paris has become an universal market, not only for the Fine Arts themselves, but for most of the branches of industry to which they are in any way allied."

Lastly, in speaking of the United States of America, the Doctor says:—"The American States, which in the course of a few generations have established so vast a scheme of municipal and political institutions, have attained to great perfection in many branches of industry, and are now beginning to turn their attention to the sciences, and also to those arts which minister to the spiritual rather than to the animal wants of man,

and which have for their high purpose the investigation of truth, and the expression of beauty through form. All who have truly at heart the advancement of civilization, and regard it as the common good of mankind, must surely rejoice at the success which has attended this new movement of the American mind."

Mr. Redgrave, like every well informed man who has taken up the subject, speaks in like terms of the steps that have been taken in other countries in relation to the education of the eye and hand of the people. He says:—"In estimating the progress of this country in ornament and in Art-workmanship, as compared with the Continental nations, there is one circumstance that must enter largely into consideration. In France, Germany, Italy, and Belgium, in addition to schools for teaching ornamental art, royal and national manufactories have been established for many years. In these no necessary expense is spared to bring to perfection the fabrics wrought in them, both as to the highest excellence of workmanship and materials, and to their embellishment by ornamental design. The best painters, sculpters, and designers, as well as men of the most scientific acquirements in botany, mineralogy, and chemistry, are among their professors; and, the works being carried on at the public expense for the attainment of excellence, the cost of repeated failures is unheeded. In such establishments a band of skilled workmen must of necessity be trained, to the ultimate benefit of the private manufacturers, and those difficulties which science had found means of surmounting, or those new processes and new materials which it had brought to light, be spread abroad for the common advantage of all. Moreover, the sight of excellence and of the products of skilled workmanship is one of the greatest stimulants to further exertion, since all Art and all Manufacture arrive at perfection by gradual advances on past labors. The workman who sees the results of the skill which has produced such works in china and porcelain as were exhibited in the Sèvres room or in the hall of the Zollverein, must feel this stimulus in no mean degree. When it is remembered what one single artist did in this country for the same manufacture, and how greatly Wedgwood and his workmen were indebted to Flaxman, we can well feel what influence a band of artists of like ability, exercising their talents to improve every department of the manufacture, and of these a continued succession, would be likely to exercise over the taste and skill of those in contact with them. Nor is this all: the excellence of one fabric awakens a desire for like excellence in others, and calls forth the same spirit of emulation. It surely cannot be doubted, therefore, that the Continental nations, and more especially France, in this manufacture, and through it in many others, have been largely benefited by such institutions; besides the amount of national reputation obtained by them from the display of the choice works which are therein produced." In referring to some French paper-hangings, he says:—they exhibit "the superiority of the French working artist. The men who carry out the designer's inventions in France must themselves have a large share of skill and art-knowledge to be able to prepare the design for the manufacturer's processes with the ability so evident in the works just remarked upon." This superiority of the French over the English art-workmen is remarked in connexion with many branches of industry, and especially

in the treatment of the human figure. In wood carving, for instance, the English are *certainly* amongst the best of imitative artists; but there is a marked deficiency apparent whenever they attempt to represent the human figure, which can never be successfully rendered on the merely imitative principle, as flowers, fruits, and other objects may. It is requisite that the workmen should have some knowledge of the structure of the body to enable him to render with effect any design containing the human form with which he may be entrusted.

The Official Report of the Jury concludes with the following passage:—"The Jury of Class Thirty having brought their labors to a conclusion, cannot refrain from expressing their hope that steps may be taken for rendering the Great Exhibition as useful after it has ceased to be, as it has proved gratifying and instructive in the course of its short existence. It is the wish to see these hopes realized that impels the Jury, even at the risk of overstepping the strict limits of their functions, to submit with great deference their views on this point to the Royal Commissioners. The foundation of a permanent industrial museum in the heart of the metropolis of trade and industry, seems to the Jury the logical and practical consequence of this Exhibition. It is in the Crystal Palace that the great truth has been impressed upon us, that art and taste are henceforth to be considered as elements of industry and trade, of scarcely less importance than the most powerful machinery. It seems also natural that this museum should in the first instance consist of the objects to which the several juries have called public attention as happy types and models for imitation. While such a museum on the one hand would be a lasting depository of industry and of the arts—it would on the other serve as the best and easiest standard of comparison by which human ingenuity might mark its progress on the opening ten years hence of a new Great Exhibition. It would serve alike as a guide and as a beacon."

These decided opinions and recommendations of a jury which included the names of foreigners having a large experience of the sort of institutions recommended, must be looked on as raising to a high place among the topics of the day the subject of supplying artistic education to the working and other classes.

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*An Account of the Means taken to Raise a Sunken Floor of a Warehouse at Mill Lane, Tooley Street.**

In the year 1849, Alderman Humphrey built a stack of warehouses at the bottom of Mill lane, Tooley street, from designs prepared for him by his architects, Messrs. Allen, Snooke, and Stock. That portion of the work which forms the substruction was carried on somewhat irregularly, and was directed in great measure by the Alderman himself. The builders were Messrs. William Cubitt and Company, of Gray's Inn road. The foundations of the piers and front wall, against the street, were put in entirely under the Alderman's own direction, so that, whatever has taken place from defective construction reflects in no manner either on his

*From the London Builder, No. 539.

architects or his builders. Some time since, we described briefly, after a personal visit, the failure in the foundation here, and the means adopted to raise the floors. On the 16th ult. Mr. I' Anson laid the particulars of the case before the Institute of Architects, and we add a portion of his statement:—

The building consists of seven stories, including the basement. The roof is a queen post roof, of about 60 feet span; the height of the top story, from the floor to the under side of the tie-beam, is 10 feet; the walls are 1½ brick thick in the recesses, and 2 bricks thick in the piers. The upper floor is constructed with wooden girders, having a bearing from centre to centre of the iron posts of 15 feet; the girders are 13 inches square; the joists, 12 inches apart, 12 inches by 3; and the bearing between the girders is 11 feet 6½ inches, or from centre to centre of the posts 12 feet 7½ inches; the girders are supported by iron posts, to which I shall hereafter refer, and their ends rest on stone templates. The height of the story next beneath the topmost floor, from the top of the floor to the under side of the joist above, is 8 feet 10 inches; the walls on this floor are 2 bricks thick in the recesses, and 2½ in the piers. This floor is constructed as a fire-proof floor, with arches 1 brick thick, in cement, springing with a rise of 12 inches and a span of 12 feet 7 inches, from iron girders, or springers; there is a layer of concrete over these arches, on which the floor surface is formed with asphalte; the abutment of the arches is stiffened by tie bolts running longitudinally through the building, one in the centre of each bay, between the iron story posts. The construction of the floor next but one to the topmost floor is similar to that of the topmost floor; the walls are 2½ bricks thick, and the height of the story, from the top of the floor to the under side of the joists, is 8 feet 9 inches. The floor next but two to the topmost floor is fire-proof, being formed of brick arches built in cement with a thickness of concrete, covered by an asphalte flooring, as already described for the floor next the topmost floor; the walls are 3 bricks thick. The height of this floor, from the surface of the asphalte to the under side of the joists above, is 8 feet 9 inches. The floor next but three to the topmost floor, in ordinary parlance the first floor, is of timber construction, and similar to that of the topmost floor, except that the spaces between the joists are filled in with concrete, supported on a layer of slates fixed between the joists by wooden fillets. The height of this floor, from the surface of the floor to the under side of the iron springer, is 8 feet 2 inches, but under the centre of the arch 9 feet 2 inches; the walls are 4 bricks thick in the recesses and 4½ in the piers. The ground floor is paved with slate, bedded on concrete, resting in the arches of the basement story, which arches are 9 inches thick, built in cement, and have a span of about 9 feet 4 inches, and a rise of 13 inches. This floor is 9 feet 10 inches to the under side of the girders, and 10 feet 10 inches to the under side of the joists; the walls of the same thickness as in the floor above. The basement floor is paved with stone, and is 8 feet 10 inches high under the centre of the arch.

The iron posts supporting the floors increase in size from the top of the building downwards; the caps are cast with the posts, and have a spread of 3 feet. The diameter of the upper story posts (or rather the width of the web) is 8 inches, and the metal web is 1 inch thick, and the centre

of the post is, I believe, hollow. The diameter of the lower story posts is 11 inches, the metal of the web is 1½ inch thick. The warehouse is thus divided into four horizontal compartments, which are, it is presumed, effectually fire-proof, and the compartment between the ground floor and first floor is further made more secure by the quasi fire-proof construction of concrete laid between the joists,—a principle which Alderman Humphrey has carried out to a much greater extent in some of his other warehouses. The total area of each floor is about 6656 feet, and the total cubical contents of each fire-proof compartment, including the thickness of the timber floor, is 133,000 cubic feet. The communication between the several fire-proof compartments is at present, and is intended permanently to be, by means of a staircase external to the building, but between the two compartments comprised between the fire-proof arches, it is by the usual internal ladder from floor to floor.

Before its completion the warehouse began to show some evidences of settlement, which, as the loading was applied, greatly increased until the settlement of the story posts reached as much, in some cases, as 10 inches, one of the first symptoms being the crushing of the arches springing from the piers in the basement.

With the exception of the great defect of putting all the floors out of level, the building suffered no further damage than that the several brick arches, and particularly those in the basement floor, were all more or less fractured, and some of the stone templates in the wall were also split.

The simple and efficacious means which have been used to rectify this defect is the subject to which I now call attention. Simple and comparatively easy as the operation may appear, I know of nothing of its kind which has been more successful; and the experiment having been conducted on a scale of some magnitude, and with such satisfactory results, I have thought it might not be devoid of interest.

The warehouse having been relieved of all its contents, except on the upper floor, which was loaded all the time, the first operation was to remove the pavement of the basement, and to shore up the warehouse on that floor. For this purpose four cast iron girders, each capable of bearing a weight of 150 tons, were inserted through the piers under the springing of the arches, and these were effectually shored up by timber shores. The next step was to sink down to the foundations of the piers. Here the concrete was found defective and soft, but the great error seems to have been in not excavating the ground down to the gravel, and placing the original concrete on it. In restoring the work this was, however, done. The first concrete was removed, and the ground below having been excavated, fresh concrete of Thames ballast and stone lime was put in, resting on the gravel. The thickness of the new concrete was from 5 to 7 feet. The lower parts of the original brick piers, which were built in mortar, were removed, sometimes in one and sometimes in two at a time, the upper parts being carried during the underpinning by the iron girders, and the piers were rebuilt with brick-work in cement. These parts having been made secure, new arches of three half-brick rims were introduced under the original arches, springing from pier to pier, and on which the skewback which carried the floor arches of the ground floor was cut. These arches were considerably crippled, and the springing line

now shows by its sagging, as it were, towards the middle of the building, how considerable a settlement has taken place, but it is now only in this part of the building that it can be observed. The floor arches were repaired and made good. The concrete covering was also partially removed, and the whole of the slate paving of the ground floor. The concrete having been made good and brought to a level, the slate pavement was relaid. The foundation having then been perfectly secured, centres were fitted to the two end bays of all the brick arches above the basement, which was shored up, and one course of bricks was removed all along the crown of the arches which were shored; against the side walls of the warehouse the arches were cut through so as to leave them quite free and clear of the walls, and the brick work round the ends of the iron springers was cut away so as to leave the ends free, and all the bolts securing caps to the wooden girders were screwed out and left loose. Stout uprights were then placed in the centre between each post, from the basement arch to the underside of the iron springer of the first fire proof floor; and twenty-eight screw jacks of various forms and power having been procured, were fixed as close as they could be conveniently to the sides of the posts, and other strong uprights were placed above the jacks up to the underside of the girders on the top floor. A man having been placed to look out on every floor, the screwing commenced, by which at every effort the floors were raised from $\frac{1}{16}$th to $\frac{1}{8}$th of an inch.

The raising was thus effected of all the floors above the first floor, and gradually, as they rose, iron wedges were applied under the caps of the first floor, and also over the uprights between the posts. This operation of screwing having been gradually carried on a little at a time, at intervals of a day or so, until the floors were raised as high as was considered safe, the screw jacks were removed, and upright shores were placed against the posts, which were then left loose, and by the aid of two small jacks they were each got up, and stone and iron bases placed under them and well wedged up. When the whole had been made secure and firm, the brick arches were repaired, and made good. The whole operation of screwing up, including the preparing for it, and making good after it, occupied two months. The jacks were worked two at a time, and there were sometimes ten men to one jack. The whole work has now been most effectually carried out, and there are few traces (except the sunk line of the springing of the basement arches) to indicate the great settlement which took place. The restoration has not, however, been carried out with mathematical precision, and it has been thought necessary to introduce some iron wedges between the iron caps and springers; and to make doubly sure, the wooden girders have had an extra camber given to them, and are blocked up with wooden blocks on the iron caps.

The warehouse has now been carefully and fully tested, and there is no further evidence of settlement or giving in any direction.

One thing which is particularly instructive in this partial failure, is the fact that the foundation of the flank wall, which was built at the same time as the foundations for the story posts, and is carried down to the same level, has not sunk. Another instance of the necessity of making the foundation for story posts and columns stronger than the continuous foundation of a wall, once came under my own observation, in the case

of the enlargement of a warehouse, where the flank wall, which had stood perfectly well, having been removed, and the warehouse enlarged by building another flank wall, removed further out by one bay, a range of posts was built on the foundation of the old wall, every one of which failed.

The cost of Alderman Humphrey's warehouse was about 12,000*l.* in all, or about 190*l.* to the square superficial. The cost of the restoration was about 1000*l.*

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*Twenty-third Meeting of the British Association for the Advancement of Science.**

Introductory Address on General Improvements in Mechanical Science during the past year. By W. FAIRBAIRN.—The first subject noticed by Mr. Fairbairn was Ericsson's Caloric Engine, from which so much had been expected. It was constructed, he said, on the same principle as the air engine of Dr. Stirling, invented ten years ago—the chief difference being, that the air in Ericsson's engine is passed through wire gauze to take up the heat, instead of through plates of iron. The great objection to the engine appeared to be that two-thirds of the power were wasted in passing the air through the gauze; and though it might be premature to pronounce an opinion before the results of the improvements lately effected were known, yet if so much of the power was required for taking up the heat, Mr. Fairbairn could not but think it must prove a wasteful expenditure of fuel.—The improvements that during the last year had been made in the application of the screw propeller were opening a new era in the history of our war and mercantile navy, of which the recent review at Spithead might be considered an indication. We were now in a state of transition between the paddle and the screw, and he had no doubt that in the progress of time great improvements would be made in the construction of the engines, and in their applicability to the work, which would materially economize space and power in our steam vessels.—Mr. Fairbairn next alluded to the construction of an immense steam vessel, which had been undertaken by Mr. Brunel and Mr. Scott Russell, of such vast dimensions that it would stretch over two of the largest waves of the Atlantic, and would thus obtain a steadiness of motion which would be a preventive against sea-sickness. This mammoth steamer is to be 680 feet long, with a breadth of beam of 83 feet, and a depth of 58 feet. The combined power of the engines would be that of 2600 horses. The ship is to be built of iron, with a double bottom of cellular construction, reaching six feet above the water line, and with a double deck, the upper and the lower parts being connected together on the principle of the Britannia tubular bridge, so that the ship will be a complete beam. It would thus possess the strength of that form of construction, and not be liable to "hogg," or break its back, as had been the case with other ships of great length. The double bottom would be a means of increased safety in other ways, for if by any accident the outer shell were broken, the inner one would prove effectual to keep out the water. As an addi-

* From the London Athenæum, September, 1853.

tional security, however, it was divided into ten water-tight compartments. The ship would be propelled by paddles and by a screw, which would be worked by separate sets of engines, so that if any accident occurred to the machinery of one, the other would be in reserve. He said he had no doubt that if properly constructed this ship would answer the expectations entertained of its capabilities and strength, and that it would form, when completed, the most extensive work of naval architecture that had ever been constructed.—The next subject to which Mr. Fairbairn adverted was the improvements making in the locomotive department of railways, particularly to an engine constructed for the southern division of the North Western Railway, from the designs of Mr. M'Connell, which was the most powerful locomotive that had yet been made for the narrow gauge. The peculiarity of construction consisted in the great length given to the fire box, in which the greatest amount of steam is always generated, and in the comparative shortness of the tubes, which were only half the usual length. The steam generated by this boiler was sufficient for any engine of 700 horse power. The engine was intended for an express train that would complete the distance from London to Birmingham in two hours. In manufacturing machinery there had also been great activity and progress during the past year, and it was gratifying, Mr. Fairbairn observed, to find accompanying this improvement in machinery a most prosperous condition in the working classes engaged in those manufactures—a prosperity which had never been equalled within his experience. He attributed this prosperous state of things to the combined operations of improvements in machinery and the removal of commercial restrictions. The improvement which he more especially noticed was that of a new combing machine of French invention, applicable alike to cotton, to flax, and to wool. It combs the fibre instead of carding it, a number of small combs being applied in succession to the cotton or flax, by which means a much finer yarn can be produced from the same material than is possible by the former processes. As evidence of the present activity and enterprise in manufacturing industry, Mr. Fairbairn mentioned the erection of a mammoth alpaca woolen manufactory, by Mr. Salt, of Saltaire, near Bradford, which was 550 feet long, 50 feet wide, and six stories high, besides offices, warehouses, and various other buildings connected with it. Their steam engines to drive the machinery would be equal to 1200 horse power, and the factory would employ upwards of 3000 hands. The cost of the whole would be upwards of 300,000*l.*, and the enterprise was that of a single individual. Mr. Fairbairn concluded his *résumé* of manufacturing progress by noticing the improvements introduced by Prof. Crace Calvert, of Manchester, in the process of smelting iron by previously removing the sulphurous vapor from coal and coke. The results had proved most satisfactory, the strength of the iron produced by this process being about 40 per cent. greater than that made in the ordinary way.

Report of the Committee appointed in 1852 *to prepare a Memorial to the Hon. East India Company on the Means of Cooling Air in Tropical Climates.* By W. J. Macquorn Rankine.—In the absence of Mr. Rankine, one of the Secretaries read the Report, which was founded on experiments with apparatus invented by Prof. Smyth, described by him at a

previous meeting of the Association. The principle of the invention consists in cooling the air by expansion. The air at the temperature of the atmosphere is first compressed in a bell receiver, and the heat generated by this compression is lowered by passing the air through a number of tubes immersed in water, by which means it acquires in its compressed state the normal temperature of the atmosphere, say 90° of Fahrenheit. The air then passes into another inverted bell receiver, where it is expanded to the ordinary pressure of the atmosphere, and during this expansion it absorbs so much heat that the temperature is reduced to 60°. It is then admitted into the room to be ventilated. The compression of the air during the experiments in the first cylinder was equal to $3\frac{2}{10}$ ins. of mercury per square inch above the pressure of the atmosphere, and the refrigerator exposed a cooling surface of 1100 square feet, which was considered sufficient to reduce the temperature of the air in passing through the tubes to that of the atmosphere, viz: 90°. The Report stated that by means of this apparatus, 66,000 cubic feet of air per hour might be cooled from 90° to 60°, by a steam engine of one horse power, which is required to raise and depress the bell receiver. The advantage of cooling the air by mechanical means instead of by evaporation, was stated to be the avoidance of aqueous vapor with which the air is injuriously charged by the evaporating process.

On Reaping Machinery. By A. Crosskill.—Mr. Crosskill gave an historical account of the invention of reaping machines, from their use by the Romans and Gauls to the present time; with a view to show that though reaping machines had not been brought prominently to notice before the Great Exhibition, such implements had long since been invented, and that the reaping machines of Messrs. M'Cormack and Hussey were constructed on the same principles as those which had been previously made in this country. Among other English inventions of reaping machines, he mentioned one by Mr. Smith, of Deanston, in 1812, which from time to time underwent improvements, and in 1835 it worked very successfully at the meeting of the Highland Agricultural Society. After that trial it was laid aside, as British farmers did not encourage, and, during the redundance of labor, did not want such machines. In 1822, Mr. Ogle, of Remington, near Alnwick, invented a reaping machine, which appears to have served as a model for Mr. M'Cormack, as his machine is in almost every particular the same as Mr. Ogle's, a description of which was published in 1826. The same circumstances which prevented the adoption of Mr. Smith's reaping machine also caused Mr. Ogle's to be laid aside; though in America, where labor is scarce and the stalk of the corn more slender and dry, and therefore better adapted for the action of mechanical cutters, M'Cormack's reaper was soon in extensive demand. It was stated by Mr. Crosskill that about 2000 of M'Cormack's machines are annually sold in the United States, and that Hussey's is in nearly equal request in that country. The celebrity acquired by those machines in the Great Exhibition induced Mr. Bell, of Scotland, who had gained a prize in 1829 from the Highland Agricultural Society for a reaping machine, to bring his invention again into the field. In 1852 he contested with Mr. Hussey at the meeting of the Highland Society at Perth, and carried away the prize; and his reaping machine had proved victorious

on several subsequent trials. It was to this invention that Mr. Crosskill particularly directed the attention of the Section. It differs in several essential points from those of M'Cormack and Hussey. In the first place, the machine is propelled before the horses, which are harnessed to a pole in the centre of the machine, and not on one side; in the next place, the cutters act like large double edged scissors, which clip the corn as the machine is propelled into it; and a further advantage is, that it gathers the corn after it is cut without requiring a man to rake it off, which is necessary in the two other machines. The arrangement of the self-acting gatherer consists of an endless band of canvas, on to which the corn falls as it is cut, and it is then thrown on one side by a continuous motion of the canvas as the machine advances. With this machine, Mr. Crosskill stated, one acre and a half of corn per hour may be cut with two horses and one man to drive them.

In the discussion which ensued, Mr. Samuelson, the maker of M'Cormack's machines, admitted Bell's reapers cut the corn better than M'Cormack's; and that the saving of the hard work required from a man in gathering the corn was an important advantage; but the draft of M'Cormack's machines, he said, is lighter, and they are less costly. It was stated that the cost of Mr. Bell's reaper is double that of Mr. M'Cormack's or Mr. Hussey's, the one being 40*l*., the other 20*l*. Mr. Crosskill stated, in reply to questions respecting the difficulties encountered in the use of reaping machines when corn is laid, that there is no difficulty in cutting and gathering laid corn, if the machines meet it inclined towards them, so that it may fall on the gathering board as it is cut. Models of the three machines were exhibited.

The Rise, Progress, and Present Position of Steam Navigation in Hull. By J. Oldham.—In this paper Mr. Oldham took a retrospective survey of the application of steam power to the propulsion of ships, with a view to prove that Hull has taken a prominent part in the introduction and improvement of the invention. In 1787 experiments were made in Hull, by Messrs. Furnace & Ashton, which resulted in the construction of a steamboat worked with paddles, that attracted the attention of the Prince Regent, by whom the boat was purchased; but it was soon after maliciously burnt. In 1814, the first steamboat on the Humber was established to run from Hull to Gainsborough. It was called the *Caledonia*, and it accomplished, under favorable circumstances of the tide, fourteen miles an hour. The first sea-going steamboat sent from Hull was in 1821; and it was supposed to be the first steamboat that plied on the east coast of England. The sea-going steamers that are now connected with the port of Hull have an aggregate tonnage of 9139, and 2749 horse power. The tonnage of the river-boats is 2218, with 1135 horse power. The other steamboats coming to Hull have a burthen of 5909 tons and 2236 horse power. There are altogether 80 steamboats trading with Hull, of which number 15 are propelled by the screw.

A discussion arose on the respective merits of the inventors of steam navigation, and the priority of their inventions; in which discussion Mr. Fairbairn, Mr. Bayley, and Mr. Thompson took part. Mr. Fairbairn said he saw the *Caledonia* enter South Shields, and that it was the first steamboat in the North after Henry Bell's on the Clyde. Bell, it was stated,

got the idea of his engine from Symington, and he made propositions to our Government, and to Napoleon during the temporary peace, for applying the principle to war ships; but the plan was rejected, as such a means of propelling ships was considered to be impracticable. In reference to Fulton's claim to be the original inventor of steam propulsion, Mr. Fairbairn said, that Fulton had most probably seen an account of Symington's experiments; but there could be no doubt that he had the precedence in bringing out steamboats in 1807, and afterwards more successful in 1810, when his steamboat was at work on the Hudson.

A Brief Description of Locking & Cook's Rotary Valve Engine, and its Advantages. By G. Locking.—In this engine a metal disk, with three apertures, slowly rotating on a flat surface, with corresponding openings connected with the boiler and the cylinders, supplies the place of the ordinary slide valves. Rotary motion is given to the valve by a vertical shaft, on which there is a pinion that is worked by a cog-wheel on the shaft of the engine. The two bearing surfaces are ground steam-tight, and an outer casing serves to confine the steam, as in the common slide valve. The advantages said to be gained by this arrangement are the diminution of friction and a more ready means of cutting off the steam and of reversing the engine. As the rotary valve has a continuous slow motion, the inconvenience and friction occasioned by the rapid reciprocating action of the slide valve is avoided. Among other advantages of this contrivance, it was stated that it costs less, is less liable to get out of order, and occupies less room. Mr. Cook, the inventor, is a working mechanic in Hull.

Mr. Fairbairn, Mr. Roberts, Mr. Hancock, and other gentlemen expressed themselves favorably of the invention, and at the conclusion of the business, the members of the Section paid a visit to Messrs. Locking & Cook's works, to inspect a steam engine constructed on this principle in action.

On a new Thermostat for regulating Temperature and Ventilation. By W. Sykes Ward.—This apparatus consists of a series of flat circular hollow cases, about one foot in diameter and one inch deep, attached together in their centres. Each case contains a small quantity of sulphuric ether, which is readily affected by change of temperature. The cases, comprising about six, are suspended one under the other, and to the lowest one is attached a weight by a cord that passes over an eccentric pulley. On an increase of temperature, the ether expands, and the weight falls down, and it is drawn up again by the pressure of the atmosphere on the external disks of the cases when the air is cooled. By connecting the weight with the ventilators of a conservatory, or other building, the temperature can be thus regulated to any required degree by a previous adjustment of the apparatus.

On a Compound Safety Valve, and *On an Improved Tubular Boiler.* By James Hopkinson.

On Railway Accidents by Collision, and their Prevention. By the Rev. Dr. Scoresby.—After adverting briefly to the numerous railway accidents caused by collision, Dr. Scoresby proposed as a means of diminishing, if not of preventing, such occurrences, the adoption of a more frequent and effectual communication by electric telegraph. His plan is

to establish telegraph stations at distances not greater than five miles apart, the connexion between them being made by separate wires, and exclusively appropriated to railway signals, and not extending continuously further than from one station to another. Whenever an obstruction occurred on the line, it should be signalled in both directions, and no train should be allowed to leave any railway station until a signal had been received from the telegraph station in advance that the line was so far clear. By the adoption of a short code of signals, these communications could be transmitted with great facility, and should any inconvenience be in the first instance experienced at junctions and cross-lines, he had no doubt that a little experience, and adaptation of the arrangements to the special circumstances, would soon remove it. The expense of such a complete system of telegraph signalling would be more than compensated to the railway companies by the avoidance of collisions, and, viewing it only in an economical point of view, the Directors would find it to their advantage to adopt such a plan. As an illustration of the pecuniary losses which railway companies sustain in consequence of accidents by collisions, Dr. Scoresby mentioned the case of a friend of his, a clergyman, who received such severe injury by a collision, that he would be for the rest of his life laid upon his back, unable to perform his clerical duties, and he and his family had to be supported at the cost of the railway company.

On Railway Collisions, with Suggestions for their Prevention. By the Rev. F. F. Statham.—The plan proposed by Mr. Statham, is to prevent collisions by adopting a more effectual means of retarding trains in motion, so that they may be brought to rest within a distance of fifty yards. He made three suggestions, the first of which was, to retard a train in motion by the expansion of wings, or of fans, to increase the resistance of the air; the second was, to employ an electro-magnetic brake, acting directly on the rails by the attraction of electro-magnets fixed to the carriages; and the third was, to cause jets of steam to issue from the front of the engine, and thus obtain a reacting resistance from the air.

In the discussion that ensued all the plans were considered. Mr. Statham's fan-retarder was shown to be altogether impracticable, since, to oppose any effectual resistance would require an expansion of acres of surface; nor were the electro-magnetic brake and the steam jets considered of much more practical utility. Dr. Scoresby's plan of telegraph signals was approved by several members, as being a more perfect carrying out of the plan which is now adopted; the chief novelty of the proposition consisting in the establishment of district wires and stations at short distances for railway purposes. Mr. Nelson, who has paid much attention to railway statistics, adduced the following curious computation in illustration of the comparatively few deaths caused by railway accidents: That if a person were born in a railway carriage, and were to be continually traveling on railways till he was killed by an accident, he would, according to the average number of passengers and deaths, live 960 years.

A Description of some of the large Valves and other Machinery which have been employed for the Discharge of Water at the Manchester Water Works. By J. F. Bateman.—Mr. Bateman described, at great length, the sources of supply and the means adopted for conveying the water

from the different collecting reservoirs to the service-reservoir in Manchester, and the peculiar valves required to cut off and regulate the water supply to the inhabitants. The magnitude of the Manchester Water Works was stated to be greater than that of the Croton Aqueduct at New York, which has been hitherto considered the largest of modern times. The three principal reservoirs will contain 500,000,000 of cubic feet of water, and there are two smaller reservoirs which hold 100,000,000; so that the total quantity stored up for the consumption of Manchester and the neighboring mills is 600,000,000 cubic feet. The furthest reservoir is 20 miles distant from Manchester, and is 420 feet above the level of the upper part of the city. The daily consumption of the inhabitants is 30,000,000 gallons, which are supplied immediately from a service reservoir 150 feet above the level of Piccadilly, at the highest part of Manchester. The valves of the main pipes which open and cut off the supply are 40 inches in diameter, and with a pressure of 150 feet on that area, it would have been impossible, without great labor of complicated machinery, to have opened and closed the valves had they been of the ordinary construction. Mr. Armstrong, of Newcastle, suggested, as a means of overcoming the difficulty, that the large valve should be divided into three, and this plan had been found to act remarkably well. A small compartment of the valve was first withdrawn, and the rush of water through it having filled the pipe, the pressure was counteracted, and the other and larger divisions of the valves could then be easily lifted. By this contrivance the mains could be opened and closed by one man. Another object to be accomplished was to arrest the flow of water in case the large pipes with such a pressure upon them should burst and flood the neighborhood. This was successfully effected by introducing into the main pipe a kind of flood gate, which was opened at a certain angle by the ordinary flow of the water, and at that inclination it held suspended, by means of a lever, a heavy weight connected with a throttle valve. When the rush of water greatly exceeds the ordinary flow, a catch that retains the lever is withdrawn, and the fall of the weight closes the throttle valve and stops the flow. This self-acting machinery has more than once prevented serious damage that would have arisen from the bursting of the pipes. Another contrivance invented by Mr. Moore, a gentleman in Mr. Bateman's office, deserves mention. The water in the reservoirs is generally beautifully clear, but during heavy rains it becomes turbid, and would be unfit for the consumption of the inhabitants without being filtered. To avoid the inconvenience and expense of filtration, Mr. Moore suggested a plan for separating the turbid water from the clear. A weir was constructed, over the edge of which, during dry weather, the water in the reservoir flows perpendicularly into a drain pipe immediately below, which conveys the clear water to the service reservoir; but in heavy rains, when the water is turbid, the extra flow shoots it over the first drain into a second, to convey it to the reservoirs that supply water power to the mills. By this simple arrangement the turbid and clear waters are separated, and it is calculated that a saving of 100,000*l.* has thus been effected. In supplying Manchester with water, a new kind of fire-plug has been adopted, consisting of a gutta percha spherical valve, which closes the apertures, and when the water is required to escape, an instrument is intro-

duced which forces down the valve. The great water pressure in the pipes forces it so high that there is no necessity for fire engines; and the effectual manner in which fires are extinguished by the torrent of water that can be thus applied has greatly diminished the cost of insurance in that city. Mr. Bateman stated, that in large establishments the diminished premiums on fire insurances produced by the increased facility of extinguishing fires are sufficient to pay the water rate. Several other arrangements of minor importance which have been introduced in the Manchester Water Works were also described by Mr. Bateman.

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*Telegraphic Progress.**

The Magnetic Telegraph Company effected their communication between this country and Ireland on Monday week, when their new cable between Donaghadee and Portpatrick was successfully laid down.

The prospectus has been issued of an association, under the title of the Mediterranean Electric Telegraph Company, formed with the object of uniting Europe with Africa, the East Indies, and Australia, by way of France, Piedmont, Corsica, Sardinia, Algeria, and Egypt. The route is said to have been carefully surveyed. The company are making arrangements for the construction of a subterranean line along the coast of Africa, from Algeria to Alexandria; and with the aid of the British Government and the East India Company, the wires may be prolonged across the Desert, the Red Sea, Arabia, and Persia, to meet the great Indian line of 3000 miles, now in course of construction by the East India Company, and which may eventually be extended to the Australian colonies. The capital is 300,000*l.* in 30,000 shares, of 10*l.* each, deposit 4*l.* per share. The Government of France is said to have guaranteed interest on 180,000*l.* and that of Sardinia on 120,000*l.* A contract has been entered into for the complete execution of the works from Spezzia to Tunis, including all preliminary expenses, and a transfer of the concessions, with exclusive privilege for fifty years, for the sum of 300,000*l.*, the amount on which interest has been guaranteed. The works are said to be already in active progress in Sardinia.

In a lecture delivered at Belfast a few weeks ago, Mr. J. B. Lindsay said that he had recently instituted a series of experiments with the view of testing an idea that he had formed some fifteen years ago—that no submarine wires are necessary for the transmission of electricity. In explanation of this principle, he said, "Suppose a wire connected with the copper end of the battery to be let down to the shore, and connected with a sheet of metal laid in the river. Suppose a wire from the zinc end taken to Broughty Ferry, and soldered to a metallic plate placed also in the river. Suppose similar plates laid in the river on the Fife side, at Newport and South Ferry, and these joined by a wire having in its course one or more telegraphs. Suppose now that a charge of electricity is sent through the wire on the Dundee side; this current may make its circuit from the copper to the zinc either by leaping four miles through the water from Broughty Ferry to Dundee, or by a leap of two miles across

* From the London Builder, No. 539.

the river to the other wire at South Ferry, and another leap of two miles from Newport to Dundee. In such a case, I have found that part of the electricity does not go across, and *part of it does;* but the part of it that does go across is sufficient to work one or ten thousand telegraphs." The possibility of this we long since noted.

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*Revolving Shutters.**

The shutter referred to by our correspondent, "J. F.," at Limerick, 45 feet long, is not so long by 6 feet as one erected by us at Water lane, Blackfriars, three years since,—passing round a corner, rolling in a space of 20 inches diameter, and opened and closed in 1½ minute: we would have no hesitation in constructing a shutter 100 or even 200 feet long on this principle. The great difficulty is to make revolving shutters with horizontal laths of great width in one piece, as the shaft or roller can have no centre support. The shutter referred to in Fleet street is 24 feet wide and 18 feet high, in one piece, and is opened or closed with ease in 30 seconds. We have recently obtained a patent for some important improvements,—first, the combining iron and wood in their construction, whereby great stiffness and lightness is obtained,—qualities, obviously of great importance; also for curving the laths of metal shutters in such a form that the joint, or hinge, is formed in the solid, greatly increasing the strength and appearance, and permitting them to be rolled in either direction, greatly facilitating their application.—*Clark & Co.*

Experimental Researches to Determine the Strength of Locomotive Boilers, and the Causes which lead to their Explosion. By William Fairbairn, C. E.†

These experiments were undertaken in consequence of the explosion of a locomotive boiler in the engine house of the North-Western Railway Company, at Manchester. It may be remembered that the immediate cause of the explosion was owing to the engine driver having screwed down the safety valve while he was talking to a companion, and leaving it in that condition. In twenty-five minutes from the time the valve was screwed down, the boiler burst with tremendous force, blowing off part of the lofty roof, and killing several men who were within the building. The boiler was a complete wreck, scarcely any portion of it remaining entire. The government inspector, who examined the wreck of the boiler shortly after the explosion, reported that the stays of the fire box had been defective, and that the boiler had not been sufficiently strong for the ordinary work. Mr. Fairbairn entertained a contrary opinion, and contended that all the parts of the boiler had been strong enough to resist six times the usual working pressure, and that the accumulated generation of steam during the twenty-five minutes that the valve had been screwed down must have amounted to a pressure of 300 lbs. on the square inch. The government inspector, however, maintained that the time was not

* From the London Builder, No. 539.

† From the London Civil Engineer and Architect's Journal, October, 1853.

sufficient to have increased the pressure to nearly that amount. In consequence of this difference of opinion, a series of experiments were instituted to determine the real causes of the explosion, and to register those facts for future guidance in guarding against such catastrophes. In the first place, Mr. Ramsbottom, the locomotive superintendent, made some experiments with the stays of the burst boiler, from which it appeared that the force required to pull the old stays out of a copper plate (similar to that of the fire box), into which they had been screwed by *the old threads only*, and not riveted, was 340 lbs. on the square inch. Mr. Fairbairn said he had carefully repeated these experiments with nearly similar results; and assuming that the ends of the screws had been riveted, and sound in other respects, it might reasonably be concluded that a strain of not less than from 450 to 500 lbs. upon the square inch would have been required to strip the screws or to tear the stays themselves asunder. It should be borne in mind, that the exploded boiler, though recently repaired, had been made many years ago, and as the cylinders were only 13 inches in diameter, it had latterly been employed only as a pilot engine to pilot the trains through the Standedge Tunnel. The stays were 5 by 5⅜ inches apart, whilst the stays of the boilers at present constructed are thicker and closer together, and form squares of 4 to 4½ inches, by which increase of strength the resisting power would be raised to nearly 800 lbs. on the square inch.

With a view to determine by actual experiment the strength and power of resistance of the locomotive boiler, the Directors of the North-Western Railway Company placed at Mr. Fairbairn's disposal an engine, the exact counterpart of the one that exploded, both having been made at the same time by the same engineers, Messrs. Sharp and Roberts, of Manchester, and both having run the same number of miles. The engine experimented on was not, however, in the same state of repair as that of the exploded one, the fire box being considerably bulged, and the rivets as well as the stays much weakened. This boiler was subjected to hydraulic pressure, and when 207 lbs. on the square inch had been put upon it, one of the bolts of the cross bar over the fire box broke, which caused the experiment to be discontinued, as the leakage was greater than the force pump could supply. This experiment fully proved that the fire box stays—on the comparative weakness of which so much stress has been laid—are not the weakest parts of a locomotive boiler; and that there is more to be feared from the top of the furnace, which, under severe pressure, is almost invariably the first part to give way. Great care, Mr. Fairbairn said, should therefore be taken in the construction of that portion of the boiler, and the cross beam should not only be strong, but the bolts by which the crown of the fire box is suspended should also be of equal strength, in order that no discrepancy should exist, and that all parts should be proportioned to a resisting force of 500 lbs. on the square inch.

The next point to be determined by the experiments was, whether the steam of the exploded boiler could have been raised from a pressure of 60 lbs., at which it blew off from the safety valve before it was screwed down, to 300 lbs. in the course of twenty-five minutes. Mr. Ramsbottom instituted some experiments on this subject, from which it appeared, that with the furnace in the ordinary condition, steam in a locomotive

boiler was raised from a pressure of 30 lbs. on the square inch to 80 lbs. in ten minutes. Mr. Fairbairn repeated these experiments to a still higher pressure with the following results, commencing at forty-four minutes past two o'clock:—

Time, h.	m.	Pressure, lbs. per sq. in.	Mean temperature, Fahr.
2	44	11·75	243·00
2	45	14·15	247·75
2	46	16·35	251·25
2	47	19·25	255·25
2	48	22·35	259·75
2	49	25·75	264·00
2	50	28·95	268·37
2	51	32·15	273·00
2	52	35·75	277·00
2	53	39·95	282·00
2	54	44·25	286·37
2	55	48·35	291·00
2	56	52·75	295·37
2	57	57·75	300·00
2	58	63·75	304·25
2	59	68·95	308·75
3	0	75·75	313·00
3	1	80·35	317·00
3	2	87·25	322·10
3	3	93·95	326·12
3	4	101·15	331·00
3	5	108·75	335·62
3	6	111·75	The thermometer did not indicate a higher temperature than the above.

In these experiments it will be observed that the pressure was raised from 11·75 lbs. on the sq. in. to 111·75 lbs. in twenty-two minutes; and on looking at the table it will be seen the pressure was accelerated in a greater ratio than the temperature. In the first experiments, for instance, the increase of pressure was about one pound for two degrees of heat; at a temperature of 277° it was as three to four; at 317°, the pressure increased about a pound for each degree; and at the end of the experiments, the proportions as four of heat to five of pressure. Mr. Fairbairn stated that he considered it more than probable, that had the instruments been calculated for higher temperatures and higher pressures, the point of explosion from 60 lbs. to 350 lbs. or 400 lbs. on the square inch would have been reached in twenty-eight minutes.

Those parts of a locomotive boiler comprised in the flat surfaces of the fire box were afterwards put to the test of experiment. Two thin boxes with flat surfaces, each 22 inches square and 3 inches deep, were constructed; one of them corresponding in the thickness of its plates ($\frac{7}{16}$-inch), distance of the stays, and in other particulars, with the sides of the fire box of the exploded boiler; and the other was formed of plates of the same thickness, but with the stays only four inches apart instead of five. The first box, therefore, containing sixteen squares of 25 inches area, represented the exploded boiler; the other, with twenty-five stays of 16 inches area, represented the new construction of boilers. When hydraulic pressure was applied to the first box, not the least swelling of the sides was perceptible till a pressure of 455 lbs. on the sq. in. had been put upon it, and then the swelling amounted to only ·03 of an inch. At a pressure

of 815 lbs. the box burst, by drawing the head of one of the stays through the copper, which, from its ductility, offered less resistance to pressure in that part where the stay was inserted. The swelling of the sides the minute before bursting was ·08 of an inch. In the next series of experiments with the box, in which the stays were placed closer together, the following results were obtained, showing the relative pressures and swellings of the sides up to 1595 lbs. on the square inch. At a pressure of 1625 lbs. the box burst, by one of the stays drawing through the plate, after sustaining the pressure upwards of a minute and a half:—

Pressure in lbs. per. sq. in.	Swelling in the sides in ins.	Pressure in lbs. per sq. in.	Swelling in the sides in ins.
485	·04	1445	·12
575	·06	1475	·13
635	·07	1495	·14
755	·08	1535	·16
965	·09	1565	·22
1355	·10	1595	·34
1385	·11		

The foregoing experiments Mr. Fairbairn considered to be conclusive as to the superior strength of the flat surfaces of a locomotive fire box, as compared with the top or even with the cylindrical part of the boiler. The enormous pressure sustained by the flat surfaces of a fire box when stayed in the manner now adopted, as exemplified in the second series of experiments, is greater than can possibly be attained in any other part of the boiler, however good the construction; in fact, there is no limit to the pressure that may be sustained if the stays be increased in thickness and in number.

In the discussion which ensued on the reading of this important paper, Mr. Samuelson observed, that as many flat marine boilers are now being constructed, it was desirable that the results of the foregoing experiments should be extensively known, as they would tend to remove the prejudice which had been so long entertained against the use of flat boilers.

In reply to a question, whether the heat requisite to get up a pressure of steam equal to the hydraulic pressure applied might not weaken the iron, Mr. Fairbairn stated, that the effect of heat on the strength of wrought iron was a subject he was about to investigate, but at present he could not give a definite answer. With respect to cast iron, he had determined that the strength increased up to a temperature of 300° Fahr., and at higher temperatures it became weakened.

Mr. Hopkinson said, that he understood experiments had been made with wrought iron in America, from which it appeared that the strength continued to increase to as high a temperature as 600°.

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*Experiments on the Effect of Re-Melting on the Strength of Iron.**

Mr. Fairbairn presented a report of experiments undertaken at the request of the Association, "On the Mechanical Properties of Metals as derived from repeated Meltings, exhibiting the maximum point of Strength and the Causes of Deterioration." In making the experiments, one ton of Eglinton hot-blast iron was operated on. The proportions of flux and coke at each re-melting were accurately measured, so as to be alike in each. The iron was run into bars 1 inch square, and the trials were made

* From the London Civil Engineer and Architect's Journal, October, 1853.

on lengths of about 4 feet, supported at each end, and the weight applied in the centre gradually, until the bar broke. One bar was reserved at each trial, and the rest of the iron was re-melted This succession of re-meltings and trials was repeated seventeen times, when the quantity of iron was so much reduced, that it was not considered desirable to continue the experiments. The results obtained prove that cast iron increases in strength up to the twelfth melting, and that it then rapidly deteriorates. The commencing breaking weight was 403 lbs., and this went on increasing until at the twelfth melting the breaking weight was 725 lbs. At the thirteenth it was 671 lbs.; at the fifteenth, 391 lbs.; at the sixteenth, 363 lbs.; and at the seventeenth melting the bar broke with 330 lbs. After the fourteenth melting, the molecules of the metal, when fractured, appeared to have undergone a decided change. There was a bright band, like silver, on the edge of the bar, whilst the middle retained the ordinary crystalline fracture; and in the succeeding meltings the metal was bright all over, resembling the fracture of cast steel. Mr. Fairbairn exhibited specimens of the iron broken at each successive melting, and he said it was his intention to have them analyzed, to ascertain the chemical change that had been effected by the repeated processes.

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*On the Combined Steam and Ether Engine.**

Mr. G. Rennie made a communication "On the Combined Steam and Ether Engine," a French invention applied to propel a ship from Marseilles to Algiers, which he had lately examined. Mr. Rennie had been requested to investigate the working power of this engine, and, accompanied by his son, he made a voyage in the vessel from Marseilles to Algiers and back. The engine was originally intended to be worked by steam, and the boiler is adapted to an engine of 30 horse power. The principle of the construction as it is now worked is this: The heat given out by the steam in condensing is applied to boil ether; the vapor thus generated is admitted into a distinct cylinder, and the work it does is so much gained from the waste heat of the steam. The condenser is surrounded by tubes containing the ether, which thus aids in condensing the steam; and as ether boils at a temperature of 100° Fahr., there is a tolerably efficient condensation of steam produced by the temperature at which the ether boils. The ether, after having done its work in its separate cylinder, is condensed in a refrigerator surrounded by cold water, and it is then again in a state to act as a condenser of the steam. The loss of either vapor by leakage during this repeated vaporization and condensation, amounts in value to one franc per hour. Special arrangements are made for dissipating the vapor that escapes, so as to prevent ignition, and with that provision Mr. Rennie considers there is no danger. In the return voyage, Mr. Rennie placed the coal under lock and key, and superintended the delivery of it, so that no deception might be practised, and he estimates the saving of fuel from this combination of ether with steam at nearly 70 per ct. It had been estimated by a French commission at 74 per cent. The French government have paid the inventor, M. Dutromblet, a large sum for the invention, and are about to put it in operation in a ship of 1500 tons burthen, with engines of 150

* From the London Civil Engineer and Architect's Journal, October, 1853.

horse power, which will have the advantage of the experience gained during the working of the present engine.

Mr. Taylor, Jr., the son of the engineer who constructed the engine of the Marseilles boat, said that there were many defects in the present arrangement, which would be remedied in the engines about to be made. The condensers are at present very imperfect, and do not expose a sufficient surface.

Mr. Sykes Ward said, that good ether does not corrode metals; therefore, there could be no objection to the employment of it on that account. The attempts that had previously been made to apply spirituous vapor as a motive power necessarily failed; because though alcohol and ether boil at a much lower temperature than water, their vapors are much heavier, and carry off as much heat at a given pressure, when applied, as steam.

Mr. Fairbairn stated, that in the best Lancashire steam engines, when working expansively, 2¾ lbs. of coal per horse power is the quantity consumed, which was nearly equal to the quantity consumed during the voyage from Algiers to Marseilles—whilst some of the steamboats on the Humber burn 10 lbs. of coal per horse power; therefore, compared with that wasteful expenditure of fuel, the steam and ether engine presented great advantages.

Other members spoke encouragingly of the combined power, though the condensation of the steam it was considered must be imperfect, as the vacuum is not good at a temperature higher than 90°.

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*French System of Iron Floors.**

These floors are composed of joists, slightly arched in the proportion of 0·005 metre in the metre; they are placed at the distance of 1·00 metre from centre to centre, and are united by *entretoises*, or flat bars of iron, at the same distance apart. These entretoises rest on the lower projecting edges of the joists, and are secured in that position by passing into, and being fastened to, a band round the joists.

On the entretoises are tied (by means of wire) square iron rods, the same length as the joists.

Certain joists have ends fitted to act specially as ties, as have also the entretoises; thus the whole being firmly built into the walls, the sides of the houses are effectually united. The iron work is then painted, and afterwards filled with pottery bedded in plaster, or with plaster alone, by which process a ceiling is formed to the apartment below; this portion of the work is done as soon as the walls are of sufficient height to receive it.

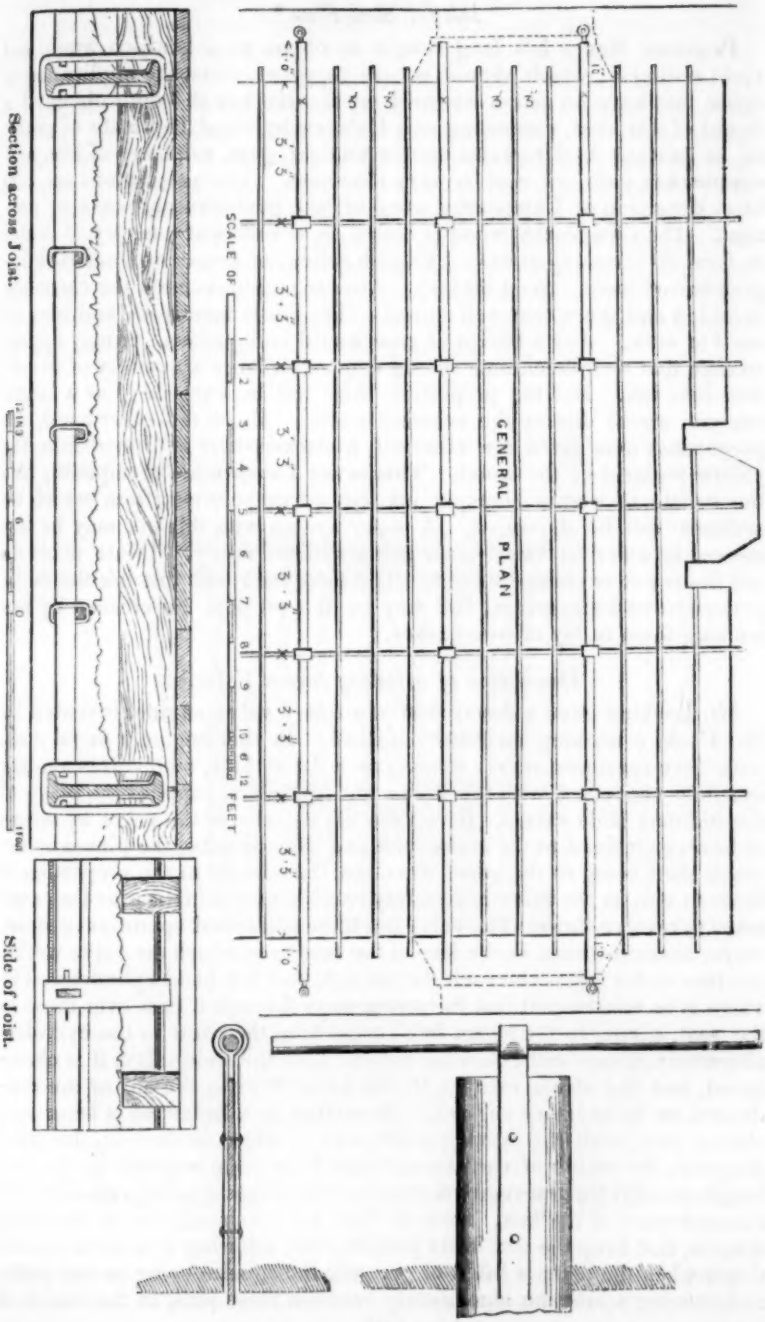
Where a wooden floor is required, it is nailed to small joists notched in between the iron work.

The joists are of rolled iron, regulated in their size and depth by their span; the other portions are made in a manner to insure their going together without the aid of forge or file at the place of construction.

The whole, complete, forms a floor at once light and fire proof, occupying about 15 per cent. less space, and adding (in Paris) little to the ordinary cost of wooden construction.

The accompanying drawing is for a span of from 5·00 to 6·00 metres, upon the system of Mr. Thuasne. H. H. B.

* From the London Builder, No. 539.



End of Joist where used as a tie.

*Ink for Steel Pens.**

Professor Runge has long sought to obtain an ink which would not yield sediment, which should adhere to paper, resist the application of acids, and have no action on steel pens. He has at length obtained a liquid of this kind, containing only Campeachy wood, chromate of potassa, and water. As it contains neither vinegar, gum, sulphates of iron and copper, nor galls, its cost is very moderate. The proportions are 500 litres decoction of Campeachy wood to 500 grammes chromate of potassa. The Campeachy wood is boiled in a sufficient quantity of water to form 80 litres (4½ litres = 1 English gallon) of decoction from 10 kilogrammes of wood (about 20 lbs). After the liquid is cool, the chromate is added and the whole well stirred. The ink is then ready and may be used at once. Any addition of gum would be injurious. It may appear strange that so little chrome should convert so large a quantity of decoction into ink. But the proportion must not be exceeded, as a larger amount would destroy the coloring matter. If, on the other hand, the proportions here given are observed, a blackish-blue is formed from the yellow pigment of the wood. This is not a suspended precipitate, like the gallate of iron in common ink, but a true solution, from which no sediment can be deposited. A paper written with this ink may be immersed in water for twenty-four hours without injury. Dilute acids do not destroy it or change its tint. The pens used with this ink should be perfectly free from grease, and may for this purpose be cleaned by immersing them in ley of wood ashes.

Description of a Rotary Steam Valve.†

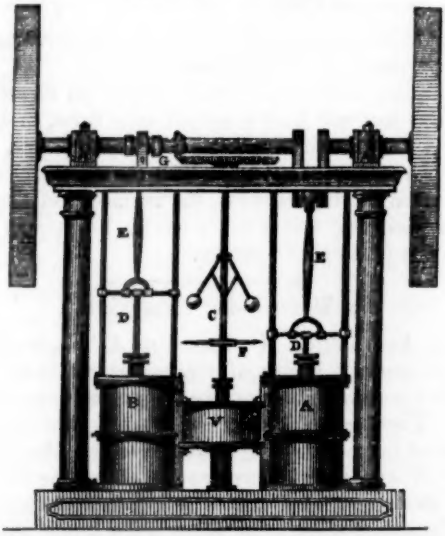
Mr. Locking gave a description of a rotary valve engine, invented by Mr. Cook, a working mechanic, of Hull. In this engine a metal disk, with three apertures, slowly rotating on a flat surface, with corresponding openings connected with the boiler and cylinders, supplies the place of the ordinary slide valves. Rotary motion is given to the valve by means of bevel gear fixed to the crank shaft and valve spindle, the pinion on the crank shaft being to the bevel wheel on the spindle in the proportion of three to one, so the valve makes only one revolution in the time the crank takes to revolve thrice. The valve has three perforated apertures or steam ways, beneath which, in the face of the seat upon which the valve works, are four steam ways, two each for the right and left hand cylinders. The valve is so constructed that the steam ways through it pass over those in the seat, giving to the steam free access from the chest to the cylinders alternately, above and below the piston. Like the slide valve, it is chambered, and the steam escapes to the exhaust pipe, the air, or the condenser, as in ordinary engines. Reversing is effected by a lever and sliding box, each end having a slot, one of which is straight, the other diagonal, the length of each being equal from point to point on the box longitudinally; the transverse distance of the diagonal being one-sixth the circumference of the box. Through these are pins made fast to the valve spindle, that keep the box in its position, only allowing it to move up and down when the lever is lifted or pressed; the spindle being in two parts, and forming a junction immediately between these pins, in the centre of

* From the London Artizan, October, 1853.

† From the London Civil Engineer and Architect's Journal, October, 1853.

the box. By moving the lever up or down, the spindle with the diagonal alters its relative position to the other with the straight slot; thus the valve is carried round one-sixth of its revolution, thereby changing the position of the steam ways, and reversing the engine. Both cylinders will receive and cut off the steam at the same point, and thus prevent one valve rod wearing more than the other, on one eccentric being before the other. Another advantage of the valve is stated to be greater facility in working the steam expansively, and cutting it off at any point of the stroke. The cost of the engines will, it was said, be much less than those now in use. Consisting, too, as it does, of little more than cylinders and cranks, it will be much less liable to get out of order. Another advantage is, the great ease with which the engine may be reversed when the steam is full on; the engineer, by the use of a single lever, can regulate to a nicety the quantity required, and ease, stop, or reverse at pleasure.

Fig. 1.—Side Elevation.



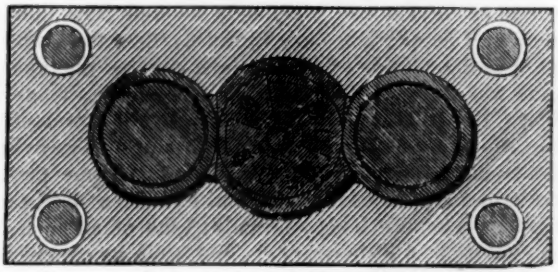


Fig. 2.—Plan (*Enlarged Scale.*)

The annexed engravings and references explain the different parts of the valve and its action:—V, valve; C, valve rod; A, B, cylinders; D, D, piston rods; E, E, connecting rods; F, reversing wheel; G, bevel wheel

and pinion for working valve. 1, aperture for the admission of steam to valve; 2, the valve upon its face in steam chest; 3, 4, steam ways above and below piston in cylinder A; 5, 6, steam ways above and below piston in cylinder B; 7, exhausting pipe into condenser, or (if high pressure) into the air; *a*, *b*, *c*, (fig. 4,) steam ways or apertures through valve to admit the steam to cylinders. The same are shown by the dotted lines on fig. 2, in which one of the apertures in valve coincides with No. 5 steam way to cylinder B; the direction of the rotation of valve is indicated by the arrow. *d*, *d*, *d*, *d*, chambers for exhausting steam through valve to exhausting pipe No. 7. *e*, *e*, *e*, shows the lap upon the valve.

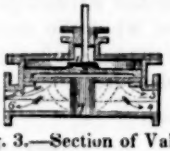


Fig. 3.—Section of Valve.

Fig. 4.—Working Face of Valve.

Mr. Oldham said, he considered it a decided improvement on any valve he had had an opportunity of examining.

Mr. Fairbairn said, it contained many important elements of improvement, but he did not see how it would save time, or how it would be more economical than the ordinary engine. Altogether, however, it appeared to him to be a very happy effort in the right direction.

At the conclusion of the business, the members of the Section paid a visit to Messrs. Locking and Cook's works, to inspect a steam engine constructed on this principle in action.

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*On Steam Boiler Explosions.**

At the British Association, Mr. Fairbairn, C. E., read a paper detailing some very interesting results of researches made for the purpose of determining the strength of locomotive boilers, and the causes which led to explosions. These researches were entered into in consequence of some difference of opinion having arisen between Mr. Fairbairn and Mr. Wynn, connected with the railway department of the Board of Trade, as to the cause of the recent explosion of a locomotive engine at Longsight. Mr. Fairbairn, upon examining the boiler a few hours after the explosion, found one side of the fire box completely severed from the body of the boiler, the interior copper box forced inwards upon the frame, and, with the exception of the cylindrical shell which covered the tubes, the whole of the engine was a complete wreck. The engine was made in 1840 by Messrs. Sharp, Roberts & Co., had been worked at a pressure of 60 lbs., and had run altogether a distance of 104,723 miles. The cylinders being only 13 inches diameter, the engine had, for some time past, been considered too light for passenger trains, and had been used principally as a pilot engine. The fire box, originally $\frac{7}{16}$ths of an inch, was, at the time of the explosion, a little over $\frac{3}{8}$ths, and, from its excellent condition, might have been supposed but to have recently been put into use; it was perfectly free from flaw, and might, but for the accident, have traveled 100,000 more miles. The engine had been in the repairing shop about three months previous to the accident, and the whole of the stays had

* From the London Civil Engineer and Architect's Journal, October, 1853.

been tested by the hammer, in the usual mode. The only point which could admit of doubt as to the safety of the boiler, was with respect to the hold which the stays might have in the fire box. Experiments, however, had proved that the force required to pull some of the stays out of a copper plate similar to the fire box, into which they had been screwed, could not have been less than a pressure of about 300 lbs. per square inch. It required a dead weight of 8204 lbs. to pull out the "stay," and, as each "stay" had to support a surface of 27 square inches, it would require a pressure of 303·85 lbs. per square inch to strip the boiler. Supposing the stays to be riveted and sound in other respects, it would require a strain of not less than from 450 lbs. to 500 lbs. upon the square inch, in order to strip the screws or tear the stays asunder. In the case of locomotives of more recent construction, where the stays were thicker, and formed into squares of from 4 to 4½ inches, the resisting force would be increased from 700 to 800 lbs. on the square inch, or at least seven times the working pressure. Considerable stress has been laid upon the weakness of the stay which united the flat surface of the boiler to the sides of the fire box. The experiments made, however, clearly indicated that the fire box stays were not the weakest parts of a locomotive boiler, and that we had more to fear from the top of the furnace, which, under severe pressure, was almost invariably the first to give way. Great care, therefore, ought to be observed in the construction of this part. The cross beams should not only be strong, but the bolts by which the crown of the fire box was suspended should also be of equal strength. It was in order to determine, if possible, by actual experiment, the laws on which these powers were founded that he had undertaken this series of experiments. The directors of the London and North Western Railway Company had placed in Mr. Fairbairn's hands an engine of the same age, constructed by the same makers, and in every respect a fac-simile of that which had exploded. The engine was subjected to hydraulic pressure in the following manner. The boiler was furnished with a valve of one inch area, and the lever gave as the weight upon the valve 35 lbs., the scale being suspended indicated 50 lbs. The abstract of the results was the following:—

No. of lbs. on scale.	Weights upon valve.	Remarks.
Lever	35	
Scale	50	
1	65	
2	80	
3	85	
4	110	With this pressure a leakage was observed at some of the joints.
5	125·5	
6	140	Leakage increased.
7	155	
8	170	Leakage still increasing.
9	185	
10	200·5	
10½	207·5	

With this last pressure one of the bolts of the cross bar over the fire box broke, which caused the experiment to be discontinued, as the leakage was greater than the force pump could supply.

It had been stated that the steam could not have been raised from 60